Records of the Australian Museum (2002) Vol. 54: 1–24. ISSN 0067-1975

A New Genus Belonging to the Family Porcellidiidae (Crustacea: Copepoda: Harpacticoida) With Three New Species from Australia

VERNON A. HARRIS

3 Windsor Way, Hervey Bay Queensland 4655, Australia
vaharris@australis.aunz.com

ABSTRACT. A new genus, *Dilatatiocauda*, is defined to accommodate three new species belonging to the family Porcellidiidae. It is characterised by maxillipeds that do not meet in the mid-line or have a fimbriate process on the basis. *Porcellidium dilatatum* Hicks, 1971 possesses these features and is moved to the new genus as the type species. Three new species, *Dilatatiocauda multidenticulata*, *D. medialis* and *D. retroseta* from northern New South Wales, Australia are described and placed in the new genus. Three previously described species, *Porcellidium tristanense* Wiborg, 1964, *P. planum* Tiemann, 1977 and *P. bipartitum* Kim & Kim, 1997, although differing in some features, are considered to fall within the parameters of the new genus.

HARRIS, VERNON A., 2002. A new genus belonging to the family Porcellidiidae (Crustacea: Copepoda: Harpacticoida) with three new species from Australia. *Records of the Australian Museum* 54(1): 1–24.

The family Porcellidiidae Sars, 1904, has a rich assemblage of species in the Indo-Pacific region, Harris & Robertson (1994), Harris (1994), Harris & Iwasaki (1996a,b; 1997). A member of the Porcellidiidae with several unusual characters was described by Hicks (1971) from Wellington, Aotearoa (New Zealand) as *Porcellidium dilatatum*. This species is remarkable in having the maxillipeds widely separated (in all other members of the Porcellidiidae the coxal lobes meet in the mid-line). Three closely related species from New South Wales, Australia show the same widely spaced maxillipeds. These four species share several unique features that are not possessed by other members of the Porcellidiidae. A new genus, *Dilatatiocauda*, is proposed to accommodate them.

Porcellidium bipartitum Kim & Kim, 1997 from Korea, *P. tristanense* Wiborg, 1964 from Tristan da Cunha and *P. planum* Tiemann, 1977 from South Africa, share the same unique set of characters, although they differ in certain other respects. Their taxonomic position and possible inclusion in the new genus will be considered in the discussion.

Methods and materials

The method of study, measurement, terminology used to describe setae and selection of type population or material, follows the procedures described by Harris & Robertson (1994) and Harris & Iwasaki (1996a). Measurements were made on formalin preserved specimens. Body length was measured from anterior edge of rostrum to posterior tip of urosome. Not all features can be seen or measured on holotype or allotype specimens and so illustrations and descriptions are based on dissected paratype material. Several dissections were made for each species in order to find at least one example of each limb orientated at a

favourable angle for measurement or illustration. Numbers on illustrations refer to slides from which they were drawn. The hyaline border and antennules have been omitted from drawings of the whole animal. The delicate hyaline membrane can be seen in Plate 2B, and in details of anterior cephalosome (Figs. 7B–E; 9B,C,G,H; 11D,E).

The scanning electron micrographs were taken on an Hitachi S225 ON SEM from gold coated, formaldehyde fixed material. Geo-spatial coordinates have been extrapolated from survey maps.

Holotypes, allotypes and paratypes of the Australian species have been deposited in the Australian Museum, Sydney (AM). Paratype material has been deposited in the Natural History Museum, London (BMNH) and the National Science Museum, Tokyo (NSM Tokyo). Some material has been deposited in the National Museum of New Zealand, Wellington, and the Queensland Museum, Brisbane, other material is held by the author.

Systematics

Family Porcellidiidae Sars, 1904

Genus *Dilatatiocauda* n.gen.

Diagnosis. Anterior of female cephalosome semicircular, rostrum prominent, projects beyond cephalosome; anterior of male cephalosome truncated, male rostrum not pointed anteriorly; hyaline border on cephalosome and metasomal epimera appears granular, ducts from marginal glands open dorsal to hyaline membrane; dorsal pits present, ornamentation of net-like or honeycomb-like ridges may be present on parts of dorsal surface; labrum (hyperstome) with two grooved plates (comb plates) located near tip of mandibular incisor process; female urosome broad, division into anterior and posterior lobes indistinct, usually indicated by feint scar, anterior lobe without lateral striations, posterior lobe rounded, typically bordered with setules, caudal arch deep (≥50% of urosome length); female caudal ramus elongate, rectangular (L/W ratio ≥3), tendency to widen distally, posterior border not pointed, bevelled or deeply notched at external corner, α & β setae close or very close (L/[α–β]>5), γ seta on posterior border, terminal setae T1 to T4 present, terminal setae T2 & T3 close together; male caudal ramus short (quadrate), widens distally, setation similar to female; male antennule without anterior comb on accessory lobe, dactylus (terminal segment of antennule) lobed or expanded at its base; maxillule endopod with six setae, exopod with two setae; maxilliped medial lobes (coxae) widely separated in mid-line, basis quadrate (not elongate), no fimbriate process on basis; P1 with conspicuous area of denticulate pegs on endopod; endopod of P3 and P4 with long straight plumulose or serrulate spinous terminal seta; female P5 exopod without ventral expansion, does not extend beyond urosome; male P5 with six terminal setae.

Remarks. The genus is characterised by the unusual shape and structure of the maxillipeds which are widely separated in the mid-line and lack both the characteristic fimbriate edge and fimbriate process common to all other genera (see Fig. 1A,D,E). The presence of labial comb plates (see Fig. 1C), shape and setation of the caudal rami (Fig. 1B) as well as the unusual straight spine-like terminal seta on P3 and P4 endopod (see Fig. 8A,C) are also characteristic. The generic name *Dilatatiocauda* (gender feminine) has been compounded from Hicks' (1971) trivial name *dilatatum* which refers to the distal widening of the caudal rami, (late L. *dilatatio* = expanded, enlarged + *cauda* = tail).

Species composition. *Dilatatiocauda dilatata* (Hicks, 1971) **n.comb.**, (synonym *Porcellidium dilatatum* Hicks, 1971: 94–98, figs. 5–7), type species; *D. multidenticulata* n.sp.; *D. medialis* n.sp.; *D. retroseta* n.sp.; *Dilatatiocauda tristanensis* (Wiborg, 1964) **n.comb.**, (synonyms *Porcellidium tristanense* Wiborg, 1964: 18–19, fig. 8; *P. peniculiferum* Tiemann, 1978: 235–241, *abb*. 1–20; redescribed by Hicks, 1982: 51–59, figs. 1–17); *Dilatatiocauda plana* (Tiemann, 1977) **n.comb.**, (synonym *Porcellidium planum* Tiemann, 1977: 69–76, *abb*. 1–22); *Dilatatiocauda bipartita* (Kim & Kim, 1997) **n.comb.**, (synonym *Porcellidium bipartitum* Kim & Kim, 1997: 142–148, figs. 1–3). A key to the species of *Dilatatiocauda* is given below.

Dilatatiocauda dilatata (Hicks, 1971)

Figs. 1, 2 & 3

Porcellidium dilatatum Hicks, 1971, 94–98, figs. 5–7.

Type material. Collected from Island Bay, Wellington, Aotearoa (New Zealand), G.R.F. Hicks (see under *Distribution and abundance* below).

Diagnosis. *Adult female*: comb plates on labrum with numerous ridges (>8); sternal plate of metasomal segment 4 with ridges, not fimbriate; caudal rami rectangular (L/W ratio 3.8), α seta proximally inserted (¼ way down ramus), terminal setae T2 & T4 large, equal in size, pinnate, seta T3 plain, very thin, seta T4 set in from medial corner (⅕ width); longest geniculate seta on antenna not longer than endopod segment 2, terminal part straight, plain; large lateral area of peg-like denticles on P1 endopod (>½ width of endopod), no denticulate pegs along medial border; P4 endopod segments not fused; no chitinous striations along anterolateral edge of female P5. *Adult male*: coupling denticles of antennule small, not conspicuous; P2 with two plumose terminal setae on endopod; P5 setae unipinnate deltoid, row of ventral setules at base of each terminal seta.

Dimensions. *Female**: length 0.92 mm (rostrum to posterior tip of urosome), cephalosome width 0.58 mm, length to width ratio 1.6. Rostrum 0.18 mm wide, ratio of body width to rostrum 3.2. Urosome width to length ratio 1.2. Caudal ramus length to width ratio 3.8; dilation index 10.3 ([distal width–proximal width]/length × 100). *Male**: length 0.63 mm, width 0.46 mm, body length to width ratio 1.4. (* Measurements taken from single paratype specimens of male and female.)

Description. *Adult female*. Anterior outline of cephalosome semicircular, rostrum prominent, with hyaline border, projects about ¼ of its width. Dorsal surface ornamentation of pits indistinct except for three or four rows of pits tangential to anterior edge of cephalosome (Fig. 2A), no patches of honeycomb-like ridges on dorsal surface, hyaline border 13 μm wide, granular. Comb plates on labrum (Fig. 1C) with numerous ridges (>8). Sternal plate of metasomal segment 4 not fimbriate (i.e., without hair-like setules),

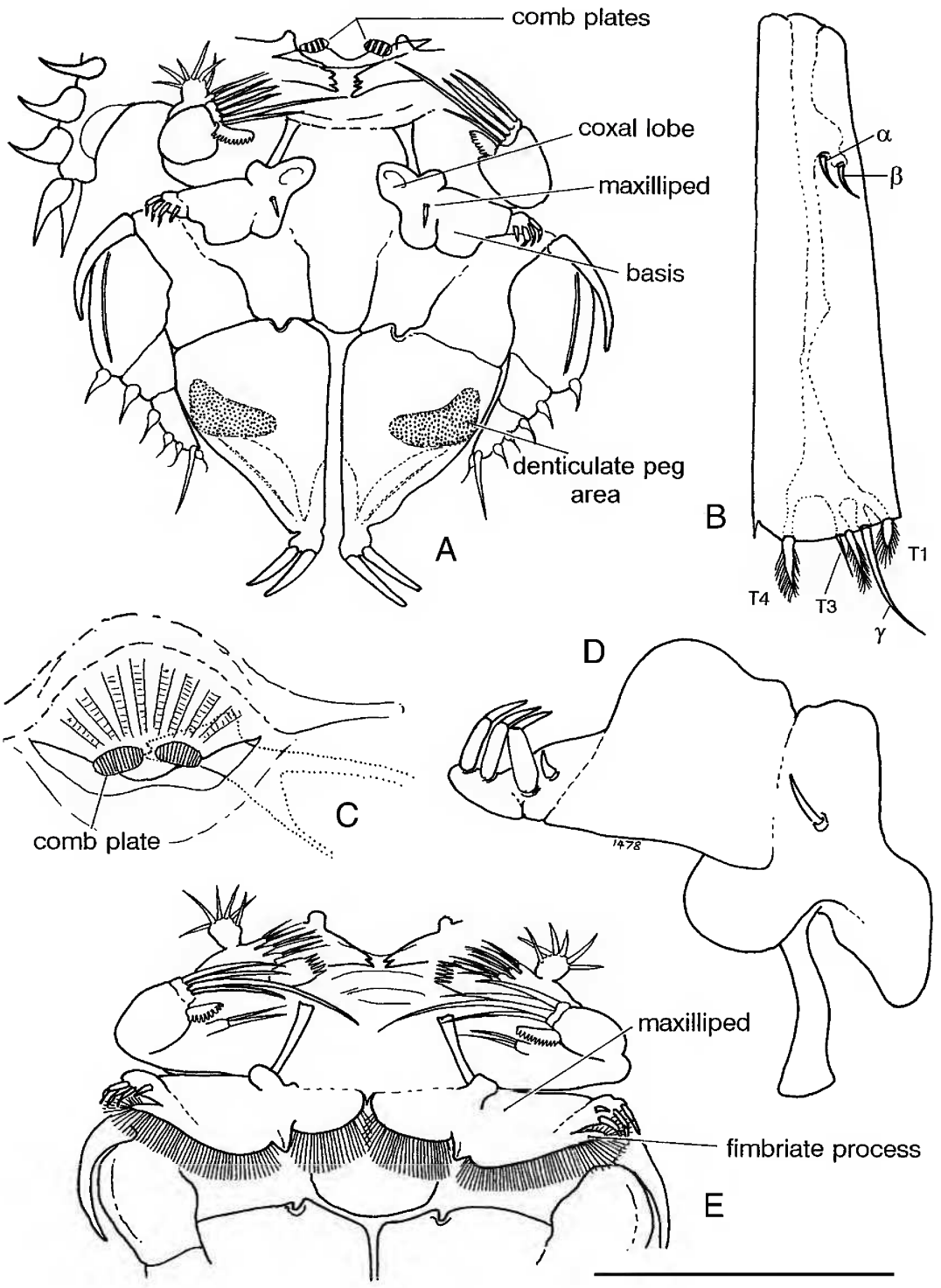

Figure 1. Characters of the genus *Dilatatiocauda* n.gen. *Dilatatiocauda multidenticulata* n.sp.: A, ventral view of mouth region and first pair of peraeopods showing combs on labrum, wide spacing of maxillipeds and denticulate areas on P1 endopod. *Dilatatiocauda dilatata* (Hicks, 1971): B, right caudal ramus showing position of α and β setae. C, combs on labrum in relation to position of mandible (dotted line). D, maxilliped showing absence of fimbriate process. *Kushia zosteraphila* Harris & Iwasaki, 1996: E, showing close juxtaposition of maxillipeds and presence of fimbriate process. Scale bar: A,E = 0.15 mm; B = 0.1 mm; C = 0.133 mm; D = 0.06 mm.

ornamented with numerous ridges running parallel to body axis (Fig. 2F). Urosome broad (Fig. 2E), very small notch and indistinct scar mark boundary between anterior and posterior lobes, anterior lobe without marginal setules, posterior lobe with strong, lanceolate marginal setules, one sensory seta on posterior border. Caudal arch deep (58% of urosome length). Caudal rami (Fig. 1B) elongate, rectangular, expanding distally, terminal border straight except for slight bevel at medial corner. Alpha seta proximal (situated about ¼ way down ramus). Hicks' index (distance

Key to the species of *Dilatatiocauda*

1 Denticulate area on P1 endopod small (less than ½ width of endopod) 2

—— Denticulate area on P1 endopod large (equal or greater than ½ width of endopod) 3

2 P4 endopod 2-segmented, α and β setae on female caudal ramus not very close (α ⅓, β ½ way down ramus) ..... *bipartita*

—— P4 endopod 3-segmented, α and β setae on female caudal ramus very close, α and β ⅓ way down ramus, sides of caudal ramus almost parallel, dorsal surface smooth (no reticulate ridges), no notch at posterior apex of female P5 ..... *plana*

—— P4 endopod 3-segmented, α and β setae on female caudal ramus very close, α and β ½ way down ramus, caudal ramus widens distally, dorsal surface with strong reticulate ridges, female P5 with notch at posterior apex ..... *medialis*

3 Geniculate setae on antenna J-shaped, much longer than segment 2 of endopod, P1 endopod with medial denticulate area 4

—— Geniculate setae on antenna L-shaped, equal or shorter than segment 2 of endopod, no medial denticulate area on P1 endopod 5

4 Female caudal ramus widens posteriorly, terminal seta T2 very small ..... *tristanensis*

—— Female caudal ramus sides almost parallel, terminal seta T2 pinnate, same size as T4 ..... *retroseta*

5 Female caudal ramus setae T2 & T3 pinnate, equal in size, male antennule with conspicuous coupling denticles, comb plates on labrum with only 4 or 5 ridges, sternum of metasome segment 4 fimbriate ..... *multidenticulata*

—— Female caudal ramus seta T3 very thin, plain, male antennule coupling denticles not conspicuous, comb plates on labrum with about 10 ridges, sternum of metasome segment 4 ridged ..... *dilatata*

of α from distal border/L × 100) = 73%. Alpha and beta setae very close (L/[α–β] = 44), terminal seta T1 short, pinnate, setae T2 and T4 large, pinnate, equal in size, seta T3 plain, thin (difficult to see on some specimens), T2 and T3 very close, seta T4 set in from medial corner (16% of width), terminal fringe of fine setules present between seta T2 and medial corner (Fig. 2I). Limbs: Antenna exopod with five plumulose setae plus one spinose seta. Segment 1 of endopod with diagonal row of triangular setules, marginal seta absent, segment 2 with two lateral setae plus six terminal setae, longest geniculate seta equal to length of segment 2, terminal part straight, plain, claw (terminal seta) comb-like. Medial lobe of maxilliped coxa reduced, widely separated from its partner (compare Fig. 1A), not fimbriate, basis quadrate without fimbriate border, fimbriate process absent (Fig. 1D). First segment of P1 exopod with conspicuous ridge of closely packed denticles parallel to edge (Fig. 3B), lateral denticulate peg area on P1 endopod large (>½ width of endopod), medial denticulate pegs absent, striated band parallel to fimbriate crescent V-shaped. Spinous seta on P3 endopod segment 2 serrulate, short (seta:endopod = 0.7:1), sickle-shaped spinous seta on segment 3 serrate, much longer than endopod (1.5:1), long straight spine-like terminal seta finely serrulate (Fig. 2D). Segments 2 and 3 of P4 endopod not fused. Coxa-basis of P5 with row of marginal setules, exopod lanceolate with falciform ridge, three dorsal setae close to apex plus one apical seta. Females with 14–16 eggs in their ovisac.

Adult male. Shoulders angular with small "epaulet", lateral angle of antennule socket not visible from above, three tangential rows of pits on anterior part of cephalosome (Fig. 2B). Rostrum does not project beyond cephalosome, rostrum width 0.07 mm, cephalosome width to rostrum ratio 6:1. Caudal ramus (Fig. 2C) short (L/W = 1.2), setation as for female, T3 same size as T2. Antennule coupling denticles not conspicuous, not obviously denticulate, accompanied by short plumose seta, anterior lobe lies almost parallel to anterior edge of antennule, ventral process (blade) present, aesthetasc not bulbous at base, dactylus (terminal segments of antennule) with expanded lobe (Fig. 2G). P2 endopod with two terminal plumose setae. P4 endopod segments 2 and 3 not fused. P5 with six unipinnate deltoid terminal setae, each seta with a row of ventral setules at its base (Fig. 2H).

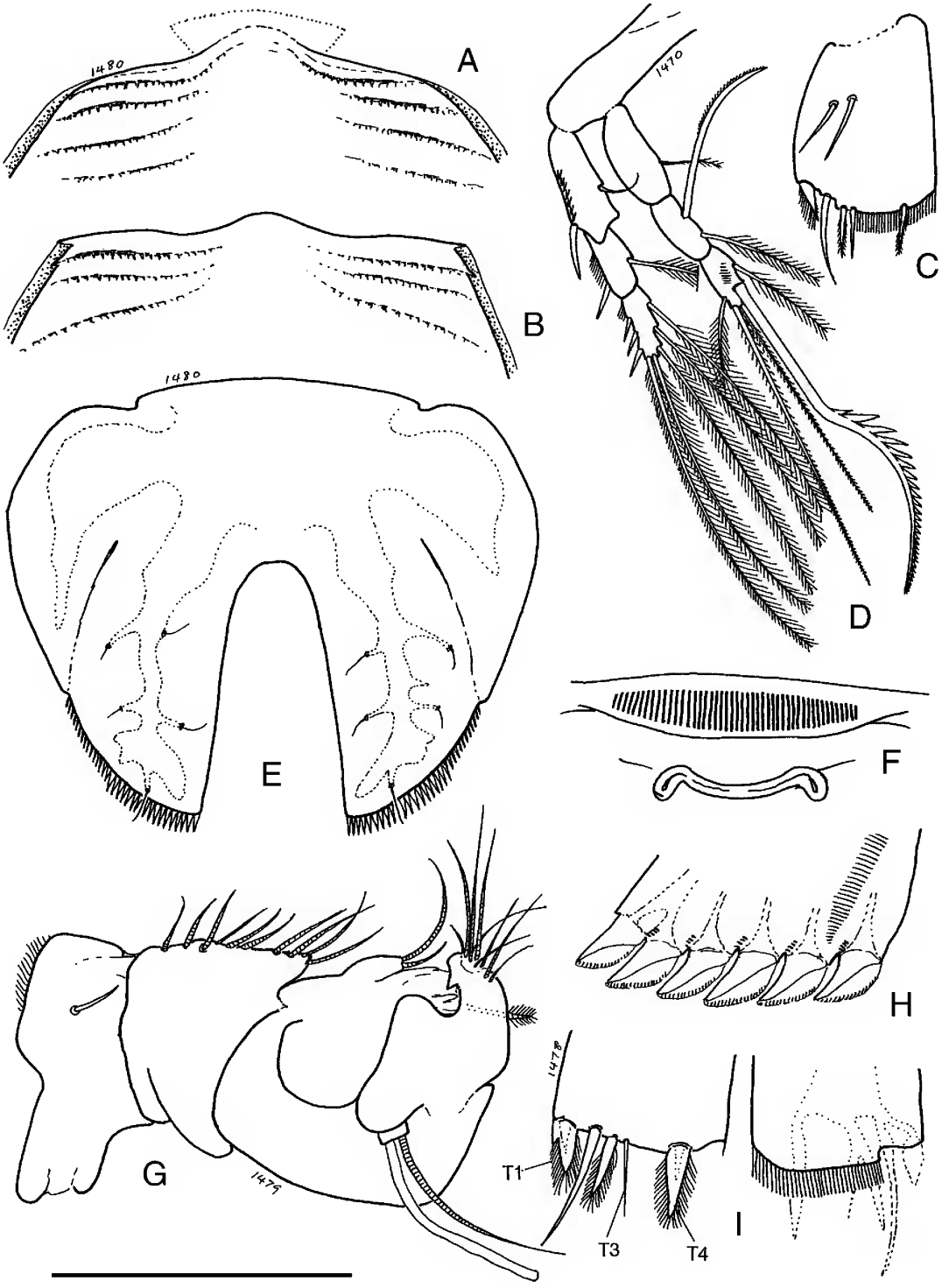

Figure 2. *Dilatatiocauda dilatata* (Hicks, 1971): A, anterior of female cephalosome, dorsal view. B, anterior of male cephalosome, dorsal view. C, left male caudal ramus. D, P3. E, female urosome, dorsal view. F, ventral view of metasome segment 4 sternal plate showing ridges. G, left male antennule, ventral view (π setae not shown). H, setae and ventral setules of male P5. I, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). Scale bar: A,B, 0.3 mm; C,G,H = 0.1 mm; D = 0.17 mm; E = 0.225 mm; I = 0.08 mm; F, not to scale.

Remarks. The above description is based on Hicks' original description and paratype material kindly supplied by Dr Hicks. Careful examination of his material reveals that the female caudal ramus has four terminal setae as well as the γ seta. However, T3 is very thin and not easily seen on female animals. On male animals T3 is the same size as T2. The terminal segment of P1 exopod has 4 pilose bulbous marginal setae, one straight seta and a plumose internal seta. The rows of setules (spinules) between terminal setae on the male P5 are located on the ventral surface of this appendage. The male antennule has an expanded lobe to the dactylus.

The ridged ventral (sternal) surface of the female's fourth metasomal segment is an easily visible diagnostic feature of this species. *Dilatatiocauda dilatata* is the type species of the genus.

Distribution and abundance. The following information is given by Hicks (1971) about type material: Holotype: holotype female is deposited in the New Zealand Oceanographic Institute (NZOI) collection, Wellington (Reg. No. 71). Paratypes: one male deposited in NZOI collection (Reg. No. P129). Pairs (1 ♂ and 1 ♀) in: Dominion Museum, Wellington (Z.Cr.1863); British Museum (Natural History) (BMNH 1969.12.1.1); U.S. National Museum (USNM 128136); NZOI collection (Reg. No. P130).

The type material was taken in a net from amongst various sub-littoral seaweeds at Island Bay, Wellington, in January 1970 (NZOI Sta. Z 2320).

Dilatatiocauda multidenticulata n.sp.

Figs. 1, 3–6

Type material. HOLOTYPE adult female with egg mass removed, length 0.85 mm, AM P58798. ALLOTYPE adult male, length 0.61 mm, AM P58799. Type population collected from *Dictyopteris* sp., infralittoral fringe, Nambucca Heads reef, New South Wales (30°37'S 152°58'E), Australia, 5.11.82, V.A. Harris. PARATYPE material: NSM Tokyo Cr13415, 30 ♀♀ & ♂♂ + juveniles. Designated paratype material from *Zonaria* sp., Ballina, N.S.W. (28°52'S 153°36'E), 2.11.82, AM P58801, 30♀♀, 11♂♂ + 7 coupled ♂♂. Designated paratype material from *Dictyopteris* sp., Ballina, N.S.W., 2.11.82, BMNH 2000.1190–1250, 40♀♀, 21♂♂.

Material collected from Sydney and the northern coast of New South Wales by V.A. Harris: BALLINA, Pontoon rocks, (28°52'S 153°36'E), 1.11.82, washed from *Pterocladia* sp.,1♀; *Sargassum* sp., 384♀♀, 48♂♂ + 113 coupled ♂♂; unidentified red seaweed 42♀♀, 6♂♂ + 9 coupled ♂♂; *Ecklonia radiata* 10♀♀, 2♂♂ + 2 coupled ♂♂; *Ecklonia radiata* holdfast 14♀♀, 10♂♂ + 7 coupled ♂♂; Zonaria sp., 21♀♀, 12♂♂ + 9 coupled ♂♂, 2.11.82, washed from *Zonaria* sp., 124♀♀, 45♂♂ + 17 coupled ♂♂ [designated paratype material]; *Dictyopteris* sp., 83♀♀, 49♂♂ + 8 coupled ♂ [designated paratype material]; *Sargassum* sp., 12♀♀, 2♂♂; *Rhodymenia australis* 1♀, 1♂ + 2 coupled ♂♂; washed from rocks encrusted with pink coralline weed 3♀, 1♂. ARRAWARRA HEADLAND, (30°03'S 153°02'E), 3.11.82, washed from *Caulerpa* sp., 2♀♀, 1♂ + 3 coupled ♂♂; *Sargassum* sp., 2♀♀, 2♂♂ + 2 coupled ♂♂; rocks encrusted with pink coralline weed 1♀, 4.11.1982, *Dictyopteris* sp., 45♀♀, 42♂♂ + 23 coupled ♂♂; *Dictyopteris* sp., + *Lobophora* sp., 39♀♀, 13♂♂ + 5 coupled ♂♂; *Caulerpa* sp., 18♀♀, 6♂♂ + 7 coupled ♂♂; mixed weed from coral pool, 26♀♀, 7♂♂ + 4 coupled ♂♂. NAMBUCCA, (30°39'S 153°01'E), 5.11.82, washed from *Sargassum* sp., 13♀♀, 6♂♂ + 5 coupled ♂♂; *Dictyopteris* sp., 169♀♀, 84♂♂ + 53 coupled ♂♂ [type population]; *Gelidium* sp., 3♀♀; mixed weed (*Hormosira, Sargassum, Caulerpa* sp.), 9♀♀, 2♂♂ + 8 coupled ♂♂; *Halimeda* sp., 1♀, 1 coupled ♂; *Sargassum* sp. and *Halimeda* sp. growing under overhanging rocks, 141♀♀, 97♂♂ + 63 coupled ♀♀; *Ecklonia radiata* 4♀♀, 1♂ + 1 coupled ♂; *Padina* sp., 33♀♀, 10♂♂ + 6 coupled ♂♂. CRONULLA, Shelly Beach rocks, Sydney, (34°03'S 151°11'E), 7.2.74, washed from *Dilophus marginatus* 3♀♀, 1♂; *Sargassum* sp., 4♀♀, 2♂♂, 21.8.75, *Dictyopteris* sp., 104♀♀, 34♂♂ + 39 coupled ♂♂, 17.2.77, *Sargassum* sp., 81♀♀, 15♂♂ + 32 coupled ♂♂; *Pterocladia* sp., 109♀♀, 30♂♂ + 4 coupled ♂♂; *Dictyopteris* sp., 270♀♀, 158♂♂ + 30 coupled ♂♂; coralline weed 14♀♀, 8♂♂; *Dictyopteris* sp., 390 animals (not sorted); *Cystophora* sp., 20 animals (not sorted); *Ecklonia radiata* 25 animals (not sorted); rocks 17 animals (not sorted); 18.2.77, *Sargassum* sp. and other seaweeds 146 animals (not sorted); *Lobophora* sp. and *Padina* sp., 20 animals (not sorted).

Diagnosis. *Adult female*: dorsal pits small, not conspicuous; comb plates on labrum with 4 or 5 ridges; sternal plate of metasomal segment 4 without ridges, posterior edge fimbriate; caudal rami elongate, rectangular (L/W = 4.0), α seta proximal (inserted ⅕ down ramus); terminal seta T1 short, thick, pinnate, T2, T3, and T4 pinnate, equal in size, seta T4 set in from medial corner (¼ width of ramus); longest geniculate seta on antenna not longer than endopod segment 2; lateral denticulate peg area on P1 endopod large (= ½ width of endopod), no denticulate pegs along medial edge; segments 2 and 3 of P4 endopod not fused; no chitinous striations along anterolateral edge of female P5. *Adult male*: antennule coupling apparatus with 3 conspicuous denticulate pads, dactylus with expanded lobe; P2 endopod with 2 terminal setae; rows of ventral setules absent at base of terminal setae on P5.

Dimensions. *Females*: mean length 0.84 mm (SD = 0.023, *N* = 30), cephalosome width 0.53 mm (SD = 0.013, *N* = 30), body length to width ratio 1.6. Rostrum width 0.15 mm, ratio of body width to rostrum 3.5. Urosome width to length ratio 1.37. Caudal ramus length to width ratio 4.0; dilation index 5.3. *Males*: mean length 0.58 mm (SD = 0.009, *N* = 21), width 0.43 mm (SD = 0.007, *N* = 21), ratio of body length to width 1.35.

Description. *Adult female* (Fig. 4A). Pale amber yellow or colourless with red eye spot. Anterior of cephalosome semicircular. Rostrum prominent with hyaline border, projects ⅖ of width (Fig. 5A). Dorsal pits small (about 1–2 μm in diameter). Scanning electron micrographs show a fine network of ridges surrounding pits and many sensory setae with basal collar (Plate 1A). Hyaline border of cephalosome 13 μm wide, granular. Comb plates on labrum short each with 4 or 5 ridges (Fig. 4G). Sternal plate of metasomal segment 4 with hair-like setules along posterior edge (fimbriate), ridges absent (Fig. 4C). Urosome broad (Fig. 4B), division between anterior and posterior lobes marked by scar and very slight notch, no cleft, anterior lobe without marginal setules, posterior lobe with strong lanceolate marginal setules, one sensory seta on posterior border, medial corner square. Caudal arch very deep (57% of urosome length). Caudal ramus (Fig. 6A) elongate, rectangular, dilation very small, sides almost parallel. Alpha seta proximally inserted (Hicks' index = 80%). Alpha and beta setae very close (L/[α–β] = 48). Terminal seta T1 short, thick, pinnate, setae T2, T3 & T4 pinnate, equal in size, setae T2 and T3 close together, seta T4 set in from medial corner of ramus (¼ of width), terminal fringe of fine setules present (Fig. 4H).

Limbs typical of family. Antenna exopod with five plumulose setae plus spinous seta (Fig. 4F). Segment 1 of endopod without seta or diagonal row of triangular setules, segment 2 with three lateral setae and six terminal setae, longest geniculate seta as long as segment 2, terminal portion straight, finely serrulate, fine comb on claw (Fig. 4F shows the small terminal aesthetasc (*) which is present on all species, but usually obscured by the geniculate setae).

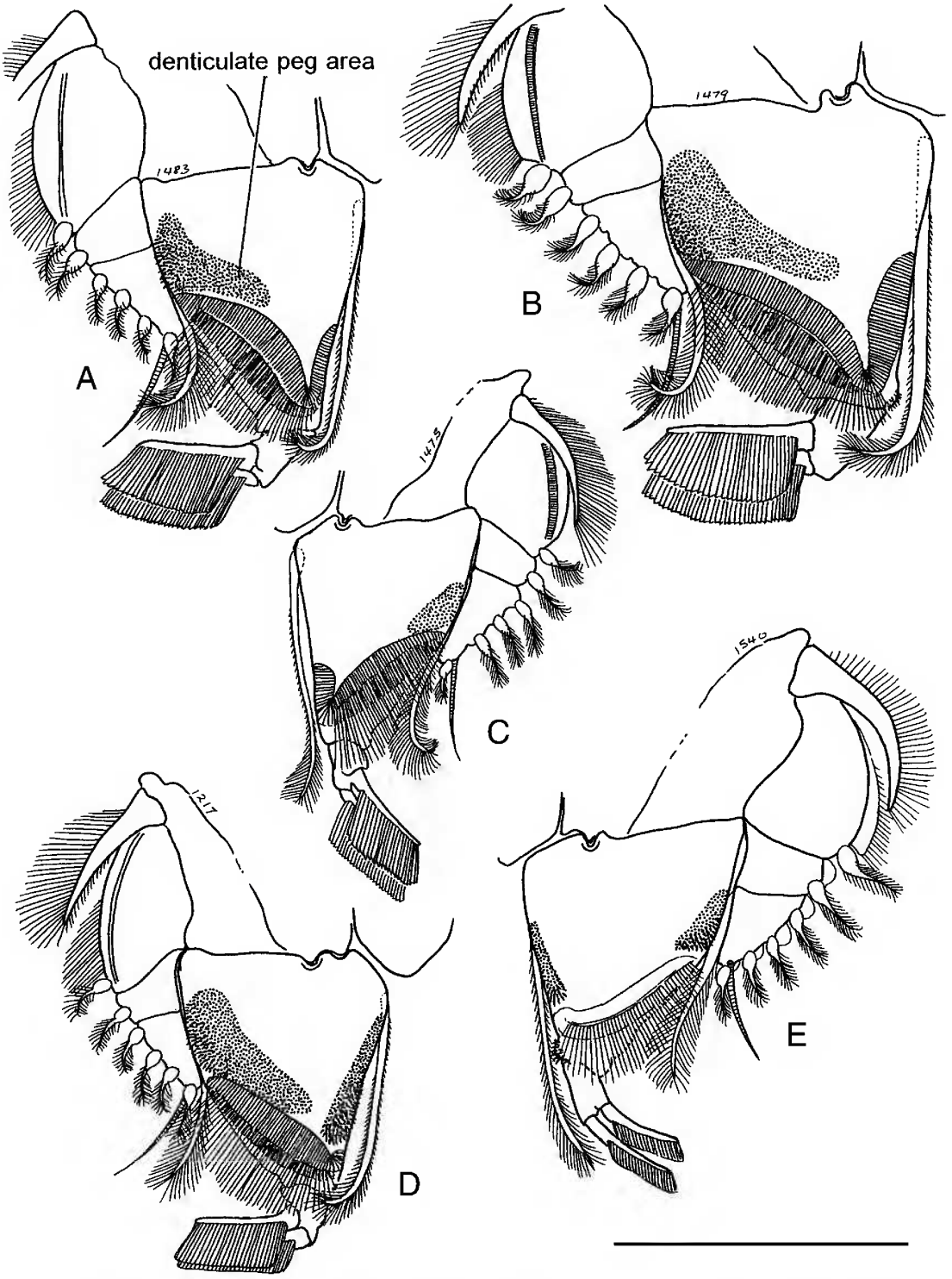

Figure 3. Comparison of first peraeopods (ventral view, denticulate area stippled). A, *Dilatatiocauda multidenticulata* n.sp., P1 right limb. B, *D. dilatata* (Hicks, 1971), P1 right limb. C, *D. medialis* n.sp., P1 left limb. D, *D. retroseta* n.sp., P1 right limb. E, *D. bipartita* (Kim & Kim, 1997), P1 left limb. Scale bar: A = 0.1 mm; B = 0.08 mm; C,D, 0.133 mm; E = 0.17 mm.

Maxilliped (Fig. 5E), coxal plates reduced, widely separated in mid-line, not fimbriate, basis broad, not fimbriate, fimbriate process absent. P1 (Fig. 3A), first segment of exopod with plain ridge parallel to edge, endopod with large triangular denticulate peg area (= ½ width of endopod), no medial peg area, striated band parallel to fimbriate crescent V-shaped. P3 (Fig. 5D), spinose seta on endopod segment 2 serrate, almost as long as endopod (0.9:1), J-shaped spinous seta on segment 3 serrate, longer than endopod (1.4:1), long straight spine-like terminal seta finely serrulate. P4 endopod segments 2 and 3 not fused (Fig. 5C). P5 exopod lanceolate, three dorsal setae near posterior end (first very

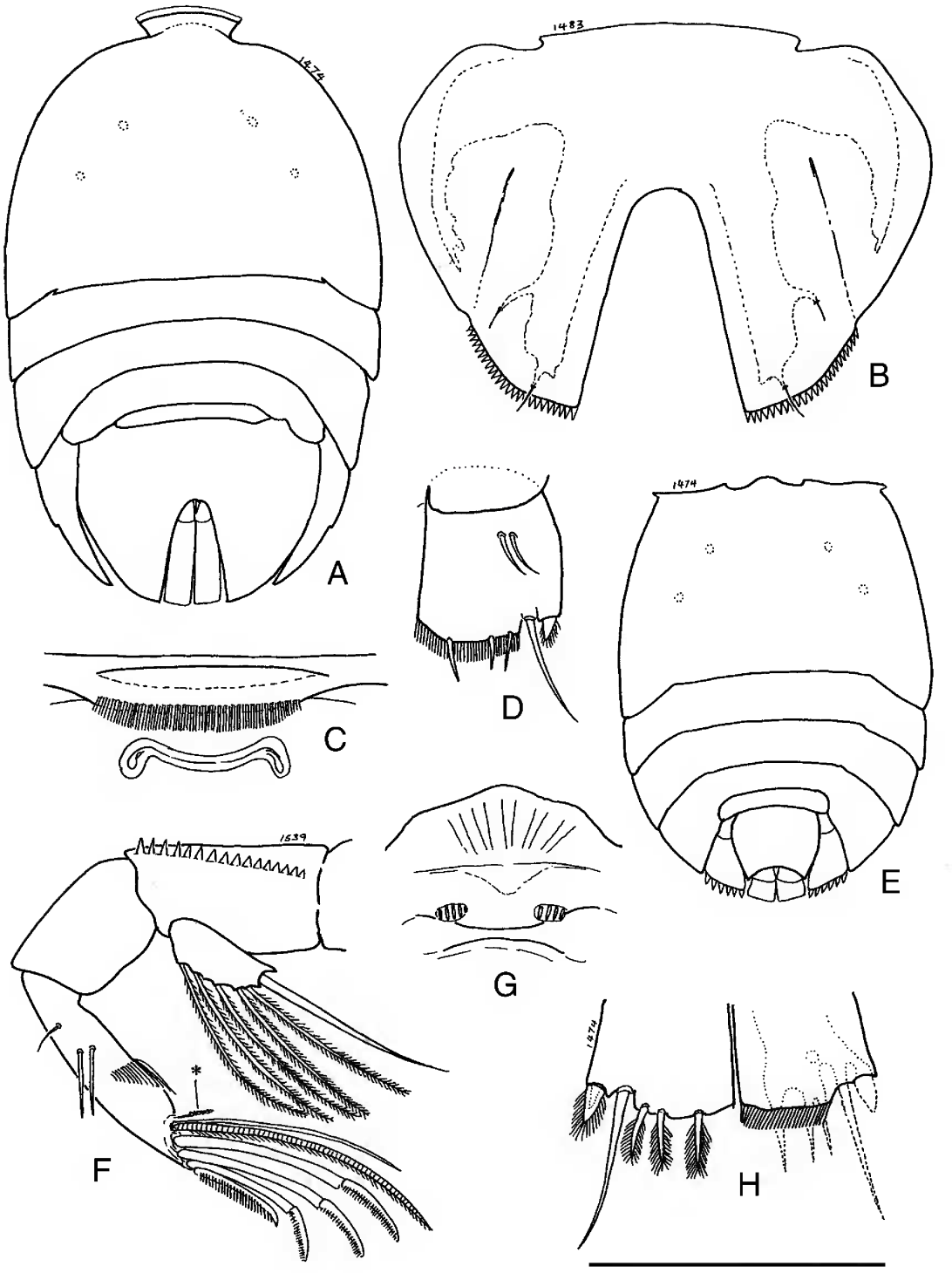

Figure 4. *Dilatatiocauda multidenticulata* n.sp.: A, female. B, female urosome, dorsal view. C, fimbriate border to metasome segment 4 sternal plate. D, male right caudal ramus. E, male. F, antenna, showing small aesthatasc (*) on endopod segment 2 just above terminal setae. G, comb plates on labrum. H, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). Scale bar: A,E = 0.45 mm; B = 0.225 mm; C = 0.133 mm; D,F,H = 0.08 mm; G = 0.125 mm.

small) plus small apical seta (Fig. 5I). Females with 10–14 eggs in ovisac (mode 12, $N = 35$).

Adult male (Fig. 4E). Yellow or colourless. Truncated anterior of cephalosome straight, shoulders angular with epaulet (Fig. 5B), lateral angle of antennule socket not seen from dorsal view. Rostrum very narrow (0.03 mm wide), cephalosome width to rostrum ratio 14:1. Caudal ramus short, almost quadrate (L/W = 1.12), setation similar to female (Fig. 4D). Anterior process and δ seta on compound segment project anteriorly (Fig. 5F,G), ventral sensory lobe with short aesthetasc and σ seta (= length of compound

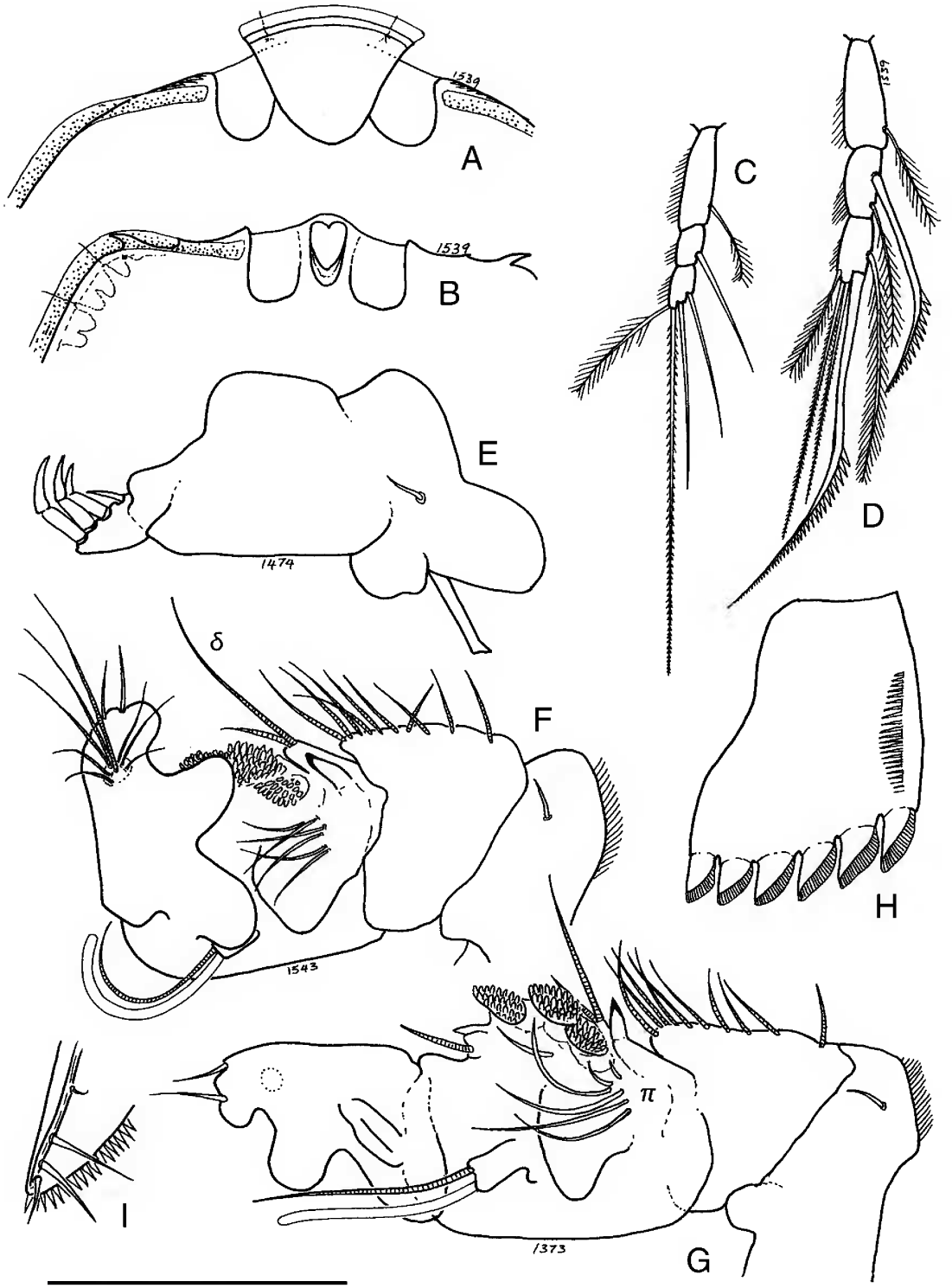

Figure 5. *Dilatatiocauda multidenticulata* n.sp.: A, anterior of female cephalosome, ventral view (hyaline border stippled). B, anterior of male cephalosome, ventral view. C, P4 endopod. D, P3 endopod. E, maxilliped. F, right male antennule, ventral view with dactylus adducted. G, same with dactylus abducted (extended) to show coupling denticles and π series setae. H, male left P5, ventral view. I, apex of female P5 showing dorsal setae. Scale bar: A,B = 0.225 mm; C,D = 0.15 mm; E = 0.06 mm; F,G,H = 0.08 mm.

segment), aesthetasc not bulbous at base, ventral process or blade present, coupling apparatus with three large, conspicuous, denticulate pads, dactylus with expanded lobe (Fig. 5G). Endopod of P2 terminates in two plumose setae. First terminal seta of P5 with row of about 20 ventral setules, no setule rows at base of other setae (Fig. 5H).

Remarks. *Dilatatiocauda multidenticulata* is easily distinguished from other members of the genus by three large, clearly visible, multi-denticulate coupling denticles on the male's antennule. The specific name refers to this feature. Scanning electron micrographs reveal a fine surface network of ridges that surround the small, indistinct dorsal

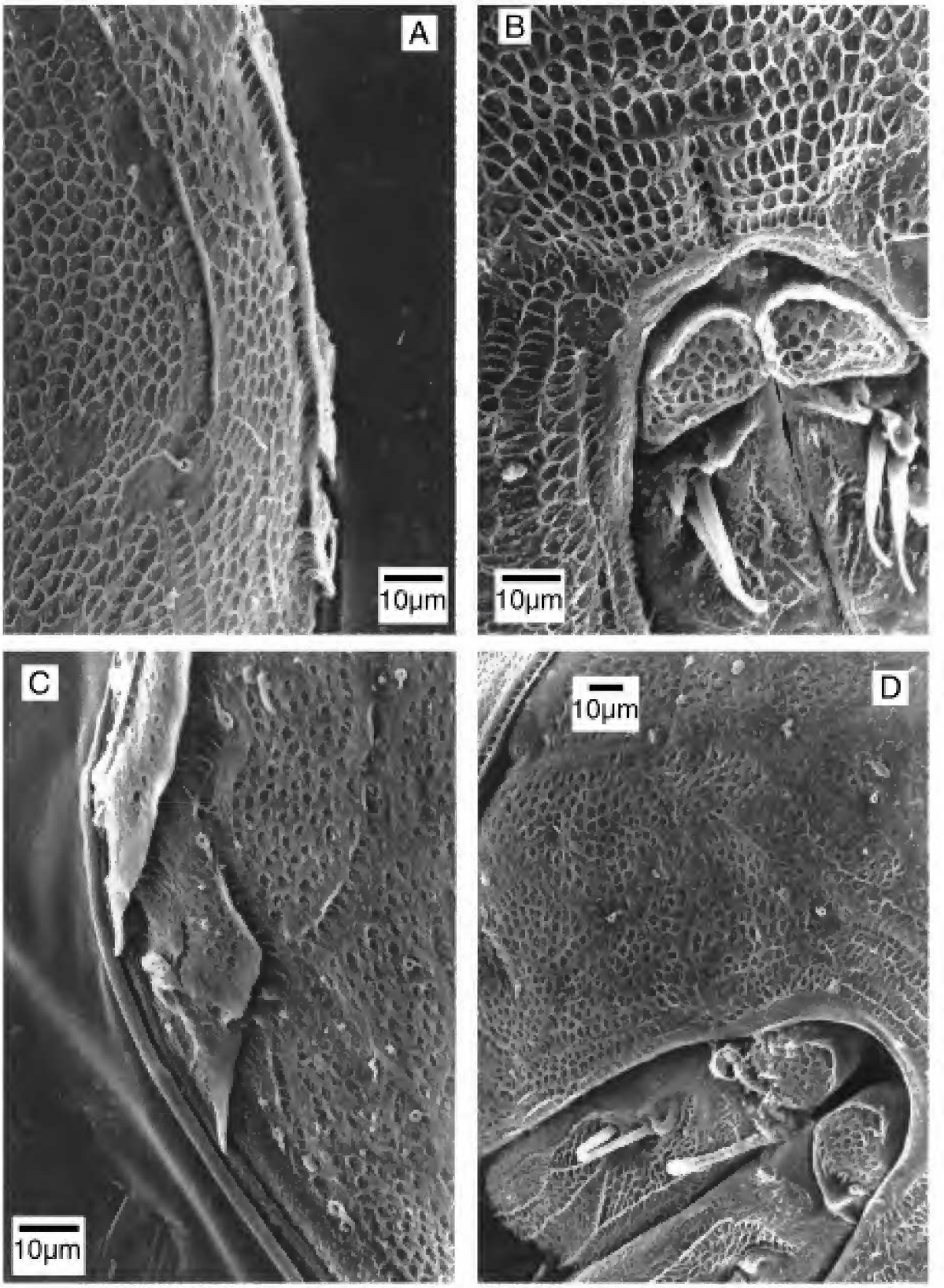

Plate 1. *Dilatatiocauda multidenticulata* n.sp. A, dorsal surface of cephalosome (right side) showing dorsal pits (c. 1–2 µm) and network of ridges surrounding pits. Several collared sensillae are visible. B, part of urosome and caudal rami showing network of strong ridges and close proximity of α & β setae. *Dilatatiocauda medialis* n.sp. C, left "shoulder" of cephalosome showing pits, collared sensillae and dorsal folds. D, part of urosome and caudal rami showing pattern of strong ridges on caudal rami.

pits (Plate 1A,B), but the dorsal surface of the cephalosome lacks honeycomb-like structures.

Distribution and abundance. This species is widely distributed along the northern coast of New South Wales. It has been recorded as abundant from Ballina on the north coast down to Sydney, but it is not known from the southern coast of New South Wales. It has not been found in the Hervey Bay–Fraser Island region of Queensland (latitude 25°S). Large populations (100+)* have been found on many species of seaweed (*Cystophora* sp., *Dictyopteris* sp., *Dilophus* sp., *Pterocladia* sp., *Sargassum* sp., *Zonaria* sp., and stones encrusted with pink coralline algae). Less frequently, it has been found on *Ecklonia radiata*, *Caulerpa* sp., and *Lobophora variegata*. (* Sample size about 0.5 kg wet seaweed.)

Dilatatiocauda medialis n.sp.

Figs. 3, 6–8

Type material. HOLOTYPE adult female without egg mass, length 0.88 mm, AM P58794. ALLOTYPE adult male, length 0.65 mm, AM P58795. PARATYPES, BMNH 2000.1251–1252, 1♀, 1♂. Type material pooled from *Sargassum* sp., (7) and *Dictyopteris* sp., (9), infralittoral fringe, rock headland Cronulla, Sydney (34°03'S 151°11'E), Australia, 17.2.77, V.A. Harris.

Material collected from Shelly Beach rocks, Cronulla, Sydney, New South Wales by V.A. Harris, 7.2.74; *Dilophus marginatus* 1♂; *Sargassum* sp., 1♀, 1♂, 21.8.75; *Dictyopteris* sp., 1♀, 17.2.77; *Dictyopteris* sp., 2♀♀; stones with coralline incrustation 1♀; *Ecklonia radiata* 2♀♀; *Dictyopteris* sp., 4♀♀, 1♂; coralline weed 1♀, 1♂; *Sargassum* sp. with other weeds 4♀♀, 1♂, 18.2.77.

Diagnosis. *Adult female*: conspicuous dorsal fold parallel to anterior edge of cephalosome; comb plates on labrum with numerous ridges (>8); sternal plate of metasome segment 4 fimbriate, not ridged; caudal rami elongate, rectangular (L/W = 3), widen posteriorly, dorsal surface with network of ridges, α seta inserted ½ way down ramus; terminal seta T3 slender, plain, seta T4 set in from medial corner; longest geniculate seta of antenna not longer than length of endopod segment 2; area of denticulate pegs on P1 endopod small (<½ endopod width), no medial peg area; segments 2 & 3 of P4 endopod not fused; no chitinous striations along anterolateral border of P5, posterior extremity of P5 notched. *Adult male*: antennule coupling denticles not conspicuous or denticulate; P2 endopod with two plumose terminal setae; P5 with ventral setule row to first seta, no setule rows at base of other terminal setae.

Dimensions. *Females*: mean length 0.92 mm ($N = 6$) range 0.88–0.93 mm, cephalosome width 0.64 mm, body length to width ratio 1.4. Rostrum 0.18 mm, body width to rostrum ratio 3.55. Urosome width to length ratio 1.25. Caudal ramus length to width ratio 3.0; dilation index 15. *Males*: mean length 0.7 mm ($N = 5$) range 0.67–0.72 mm, cephalosome width 0.58 mm, body length to width ratio 1.2.

Description. *Adult female* (Fig. 7A) pale yellow or colourless. Anterior outline of cephalosome rounded, slightly truncated, body outline ellipsoidal. Rostrum broad, prominent with hyaline edge, projects ⅓ of its width. Dorsal surface of body ornamented with pits (c. 3 μm), conspicuous dorsal fold parallel to anterior edge of cephalosome (Fig. 7B,C and Plate 1C), conspicuous reticulate ridges on dorsal surface of caudal rami (Fig. 6B and Plate 1D). Hyaline border 13 μm wide, granular in appearance. Comb plates on labrum (Fig. 8F) with numerous ridges (>8). Sternal plate of metasomal segment 4 not ridged, posterior border with fine hair-like setules. Urosome broad (Fig. 7I), no cleft, small notch and scar mark boundary between anterior and posterior lobe. Anterior lobe without marginal setules, posterior lobe with strong marginal setules, two sensory setae on posterior border, medial corner square. Caudal arch very deep (66% of urosome length). Caudal rami elongate, lateral edge slightly convex, widen posteriorly (Fig. 6B). Alpha seta near middle of ramus (Hicks' index 55%). Alpha and beta setae close (L/[α–β] = 18). Terminal seta T1 short, thick, pinnate (Fig. 7J), setae T2 and T4 longer, pinnate, seta T3 plain, slender, very close to T2, T4 set in from medial corner (¼ ramus width), terminal fringe of fine setules present between T2 and medial corner.

Limbs typical of family. Exopod of antenna with five plumulose setae and one spinous seta. Segment 1 of endopod without seta or marginal setules, longest geniculate seta not longer than segment 2, terminal part straight finely serrulate, claw long with fine comb-like edge (Fig. 7F). Coxal lobe of maxillipeds reduced, widely separated from opposite side, not fimbriate; basis quadrate, not fimbriate, fimbriate process absent (Fig. 7G). First segment of P1 exopod with denticulate ridge parallel to edge (Fig. 3C), lateral denticulate peg area on endopod of P1 small (<½ width of endopod), no denticulate pegs along medial edge, striated band parallel to fimbriate crescent V-shaped. Spinous seta on P3 endopod segment 2 slender, serrulate, almost as long as endopod (0.9:1), sickle shaped serrate spinous seta on segment 3 longer than endopod (1.5:1), long straight spinous terminal seta on segment 3 serrulate (Fig. 8C). External spinous seta on segment 1 of P3 and P4 exopod very long (= segment 1), segments 2 and 3 of P4 endopod not fused (Fig. 8A). P5 exopod ovo-lanceolate, expanded dorsal part does not reach back as far as posterior apex and leaves a conspicuous notch close to the four terminal dorsal setae near apex (Fig. 8B), marginal setules strong, anterolateral chitinous striations absent.

Adult male (Fig. 7H). Pale yellow or colourless. Shoulder rounded with two dorsal folds parallel to anterior edge of cephalosome and ending in a small epaulet laterally (Fig. 7D,E), hyaline border passes round shoulder, lateral angle of antennule socket not prominent. Rostrum broad (0.07 mm), cephalosome width to rostrum ratio 8. Caudal rami quadrate (L/W = 1), dorsal surface with reticulate ridges, setation similar to female (Fig. 8D). Coupling denticles on antennule elongate, tooth-like, not denticulate, associated seta plumose (Figs. 8G,I), δ seta projects anteriorly, ventral process (blade) with finely ridged surface (Fig. 8H), aesthetasc without bulbous base, dactylus with large basal expansion. P2 endopod terminates in two plumose setae. First terminal seta of P5 with long row of ventral setules, remaining setae without row of setules at their base (Fig. 8E).

Remarks. *Dilatatiocauda medialis* is characterised by the position of the α seta which is inserted about the middle of the caudal ramus. The specific name refers to this feature

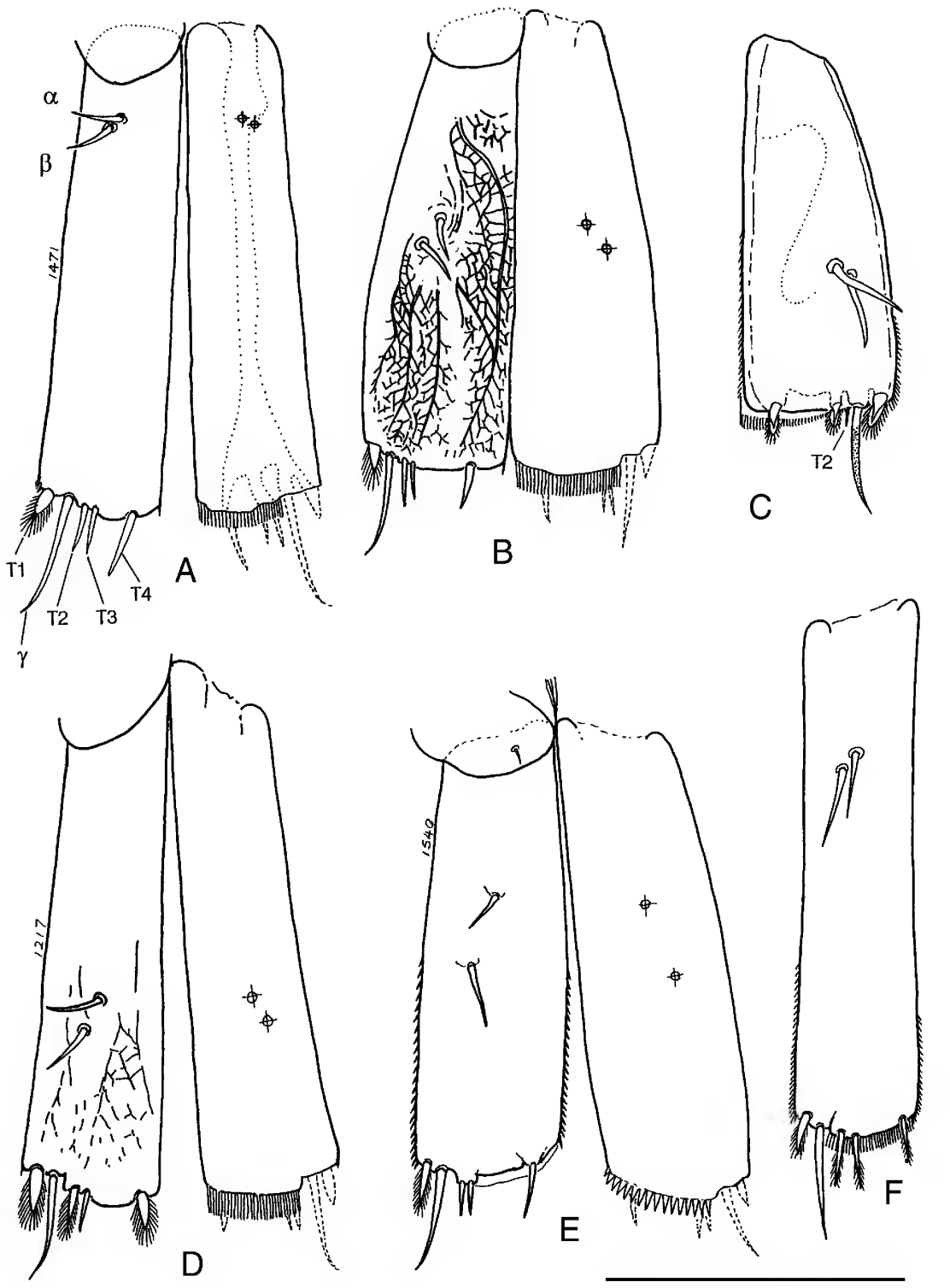

Figure 6. Comparison of caudal rami (left dorsal focus, right ventral focus). A, *Dilatatiocauda multidenticulata* n.sp. B, *D. medialis* n.sp., showing dorsal reticulate pattern. C, *D. tristanensis* (Wiborg, 1964), right caudal ramus, after Hicks (1982). D, *D. retroseta* n.sp. E, *D. bipartita* (Kim & Kim, 1997), (left ramus slightly foreshortened). F, *D. plana* (Tiemann, 1977), left caudal ramus, after Tiemann (1977). Scale bar: A,B,D,F = 0.1 mm; C,E. = 0.133 mm.

(L. *medius* = middle). Other distinctive features are the broad oval body (L/W = 1.4) and the conspicuous reticulate ridges on the caudal rami.

Distribution and abundance. No large population of this species has been found. The pooled type material has been separated from populations of the more abundant *D. multidenticulata* with which it is associated. Animals in small numbers have been found on *Sargassum* sp., and *Dictyopteris* sp., at Cronulla, Sydney, New South Wales.

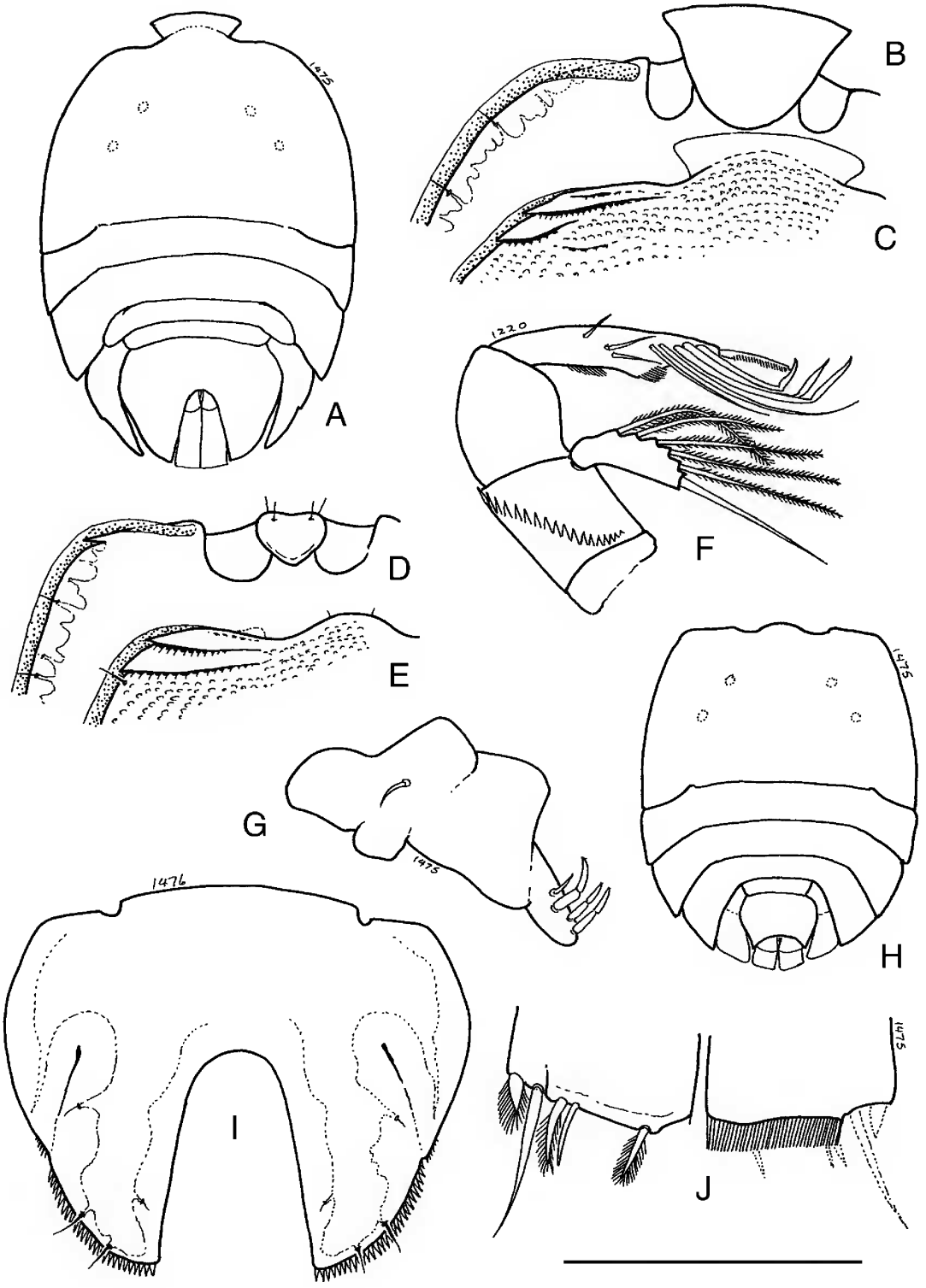

Figure 7. *Dilatatiocauda medialis* n.sp.: A, female. B, anterior of female cephalosome, ventral view (hyaline border stippled). C, same, dorsal view. D, anterior of male cephalosome, ventral view. E, same, dorsal view. F, antenna. G, maxilliped. H, male. I, female urosome, dorsal view. J, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). Scale bar: A,H = 0.6 mm; B,C,D,E = 0.3 mm; F = 0.1 mm; G,J = 0.08 mm; I = 0.225 mm.

Dilatatiocauda retroseta n.sp.

Figs. 3, 6, 9, 10

Type material. HOLOTYPE adult female without egg mass, length 0.94 mm. AM P58796. ALLOTYPE adult male, length 0.7 mm. AM P58797. PARATYPES AM P58802, 2♀♀, 2♂♂ + coupled ♂; BMNH 2000.1253–1254, 1♀, 1♂; NSM Tokyo Cr13416, 1♀, 1♂. Type material pooled from *Dictyopteris* sp., (49), plus *Sargassum* sp., (8), *Cystophora* sp., (2), *Ecklonia radiata* (8), infralittoral fringe rocks, Cronulla, Sydney (34°03'S 151°11'E), Australia, 12.2.77, V.A. Harris.

Material collected from Shelly Beach rocks, Cronulla, Sydney, New South Wales by V.A. Harris. 7.2.74, washed from *Sargassum* sp., 1♂. 21.8.75, *Dictyopteris* sp., 1♀, 2♂♂ + 2 coupled ♂♂. 17.2.77, *Dictyopteris* sp., 1♂ + 2 coupled ♂♂; *Sargassum* sp., 2♀♀; *Cystophora* sp., 2 coupled ♂♂; stones with coralline incrustation 1♂; *Ecklonia radiata* 4♀♀, 4♂♂; *Dictyopteris* sp., 21♀, 19♂ + 1 coupled ♂; *Sargassum* sp. with other weeds 2♀, 1♂ + 1 coupled ♂; *Sargassum* sp., 1♂.

Diagnosis. *Adult female*: dorsal ornamentation a network of ridges and oval areas of honeycomb, ventral surface of cephalosome wrinkled; sternal plate of metasome segment 4 fimbriate, not ridged; comb plates on labrum with many ridges (>8); caudal ramus elongate, rectangular (L/W = 3.2), α seta ⅔ down ramus, terminal setae all large, pinnate, seta T3 close to T2, seta T4 close to medial corner; geniculate setae of antenna long, J-shaped (twice length of endopod segment 2), terminal part curved, pectinate; lateral denticulate peg area on P1 endopod large (>½ endopod width), large medial peg area present; segments 2 & 3 of P4 endopod not fused; anterolateral edge of P5 exopod with chitinous striations. *Adult male*: aesthetasc on antennule with bulbous base, coupling denticles small; P2 endopod terminates in two plumose setae; P5 with rows of setules at the base of each terminal seta.

Dimensions. *Females*: mean length 0.93 mm (SD = 0.026, *N* = 20), cephalosome width 0.61 mm (SD = 0.019, *N* = 20), body length to width ratio 1.52. Rostrum width 0.12 mm (SD = 0.005, *N* = 20), ratio of body width to rostrum 5.1. Urosome width to length ratio 1.33. Caudal ramus length to width ratio 3.2, dilation index 7.3. *Males*: mean length 0.67 mm (SD = 0.019, *N* = 19), cephalosome width 0.53 mm (SD = 0.014, *N* = 19), ratio of body length to width 1.26.

Description. *Adult female* (Fig. 9A) pale yellow or colourless. Anterior outline of cephalosome semicircular, rostrum prominent. Scanning electron micrographs reveal a fine network of ridges covering the dorsal surface of the body (Plate 2A & B), several more prominent ridges run parallel to the anterior border of the cephalosome and in various directions elsewhere. Towards the mid-line, there are many oval areas in which the cuticle is raised up to form a network of ridges that resemble honeycomb (see Plate 2C & D). Ventral surface of cephalosome wrinkled (Fig. 9B). Numerous sensillae with basal collar are scattered over the dorsal surface, dorsal pits between ridges about 2 μm. Hyaline border, granular, 15 μm wide. Small patch of setules anterior to labrum, cuticle of labrum wrinkled, comb plates with numerous ridges (>8) (Fig. 10C). Sternal plate of metasome segment 4 with hair-like setules, no ridges. Urosome broad without lateral notch or cleft (Fig. 9K), boundary between anterior and posterior lobes not distinct, anterior lobe without marginal setules, posterior lobe with large marginal setules, one sensory seta on posterior border, medial corner square. Caudal arch very deep (60% of urosome length). Caudal ramus elongate, rectangular, expanded distally, dorsal surface with a few reticulate ridges (Fig. 6D). Alpha seta inserted distally (Hicks' index = 33%). Alpha and beta setae close together (L/[α–β] = 16.6). Terminal setae T1,T2 & T4 large, equal in size, pinnate, seta T3 slender, close to T2, seta T4 close to medial corner (set in ⅛ of width), terminal fringe of fine setules (Fig. 9J).

Limbs typical of family. Antenna exopod with five plumulose setae plus spinous seta (Fig. 10A), basis and segment 1 of endopod with triangular setules along edge, segment 1 without seta, segment 2 with three lateral and six terminal setae, geniculate setae very long, J-shaped (longest about twice length of endopod segment 2), terminal section curved, pectinate (comb-like with one row of teeth), claw long, pectinate. Posterior lobe of mandibular palp has four bulbous pilose setae with wing-like expansion at their base (Fig. 10E), anterior lobe with small area of hair-like setules. Maxilliped coxal lobes reduced, widely separated in mid-line, edge fimbriate (Fig. 9D), basis not fimbriate, fimbriate process absent. First segment of P1 exopod with ridge parallel to edge (Fig. 3D), lateral denticulate peg area on endopod large (>½ endopod width), medial denticulate peg area along inner edge, striated band parallel to fimbriate crescent /-shaped. P3 (Fig. 10H), spinous seta on segment 2 of endopod serrulate, equal in length to endopod, J-shaped serrate spinous seta on segment 3 longer than endopod (1.2:1). Segments 2 & 3 of P4 endopod are not fused (Fig. 10B). P5 exopod lanceolate (Fig. 10F), four dorsal setae near apex (first very small), anterolateral border with 10 to 15 chitinous striations (Fig. 10G). Females with 6 to 9 eggs in ovisac (mode 8).

Adult male (Fig. 9F). Yellow or colourless. Truncated anterior border of cephalosome convex in mid-line, concave at either side, lateral angle of antennule socket prominent (Fig. 9G,H). Surface ornamentation as for female. Rostrum 0.07 mm wide, cephalosome width to rostrum ratio = 8. Caudal ramus short, rectangular (L/W = 1.25), setation similar to female (Fig. 10D). Coupling apparatus on antennule not conspicuous, one small denticle with fine denticulations and plumose seta (Fig. 10I,J), aesthetasc swollen near base, dactylus terminates in small projection, base of dactylus expanded (Fig. 10I,K). P2 endopod (Fig. 9E) with two plumose terminal setae. First seta on P5 with long row of ventral setules (>20), short row of setules at base of each remaining seta (Fig. 9I).

Remarks. *Dilatatiocauda retroseta* is the largest of the three species described from Australia and its general proportions closely resemble *D. dilatata* as figured by Hicks (1971). However, it is distinguished from the latter by the very low position of the α seta on the caudal ramus, very long J-shaped geniculate setae on the antenna, a curiously swollen aesthetasc on the male antennule and the absence of ridges on the sternal plate of metasome segment 4. The specific name refers to the position of the α seta (L. *retro* = backward, behind + *saeta* = bristle).

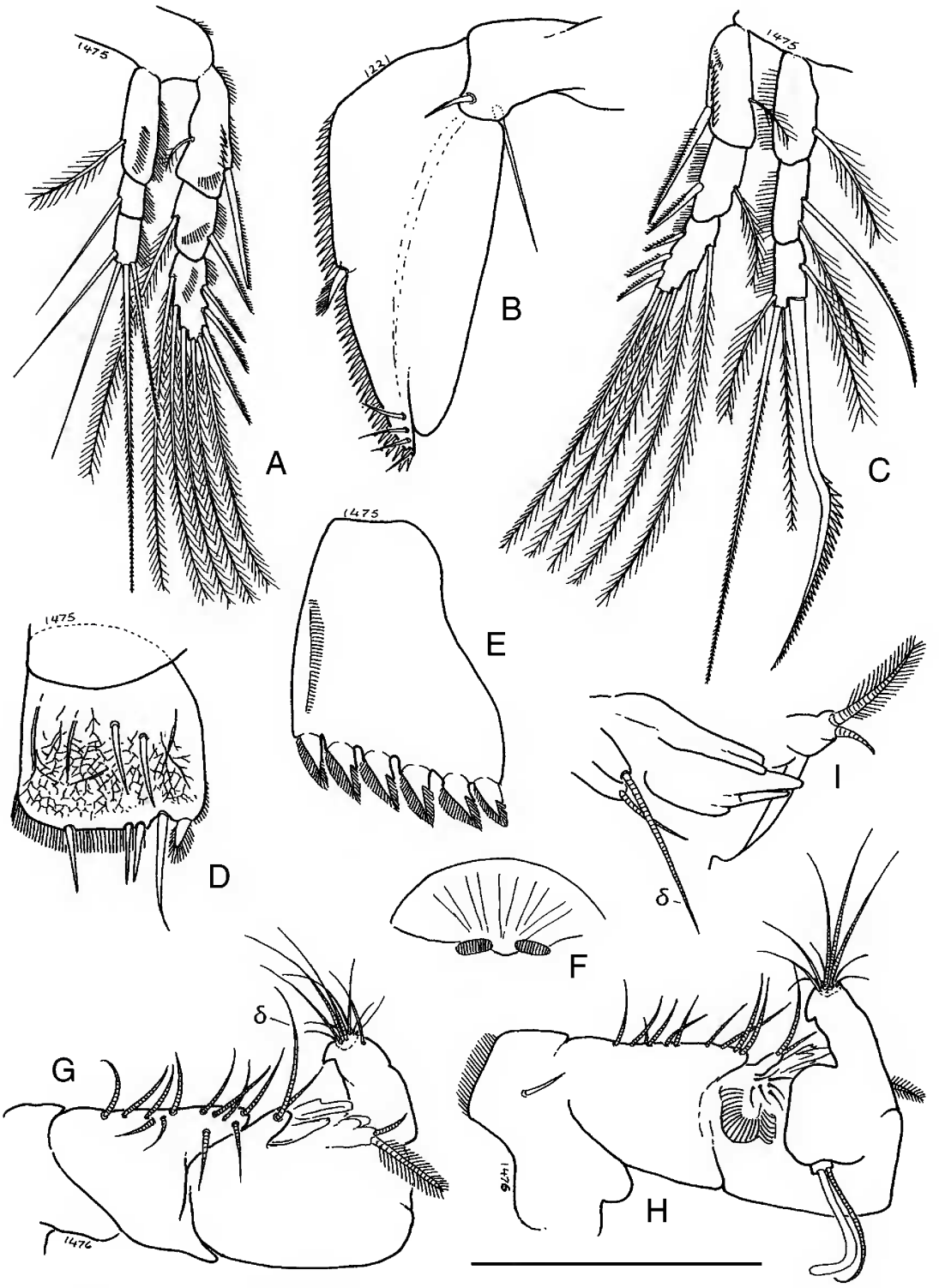

Figure 8. *Dilatatiocauda medialis* n.sp.: A, P4. B, female P5, dorsal view. C, P3. D, male right caudal ramus. E, male P5, ventral view. F, combs on labrum. G, male right antennule seen from dorsal side. H, left antennule, ventral view (dactylus obscures coupling denticles). I, coupling denticles, dorsal view. Scale bar: A,B,C = 0.15 mm; D = 0.08 mm; E,G,H = 0.1 mm; F = 0.133 mm; I = 0.06 mm.

This species shows a remarkable resemblance in many of its features to the animal described by Wiborg, 1964 as *Porcellidium tristanense*. Most striking is the similarity of the antennae. In both species the geniculate setae are J-shaped and about twice the length of endopod segment 2 (in *P. tristanense* the curved end piece has a double comb edge). Other similarities are the position of the α seta on the caudal ramus; a fimbriate border on the coxal lobe of the maxilliped; presence of denticulate pegs on the medial edge of P1 endopod; female P5 with chitinous striations on the anterolateral border and setules at the base of each terminal seta on male P5. Despite these resemblances, the

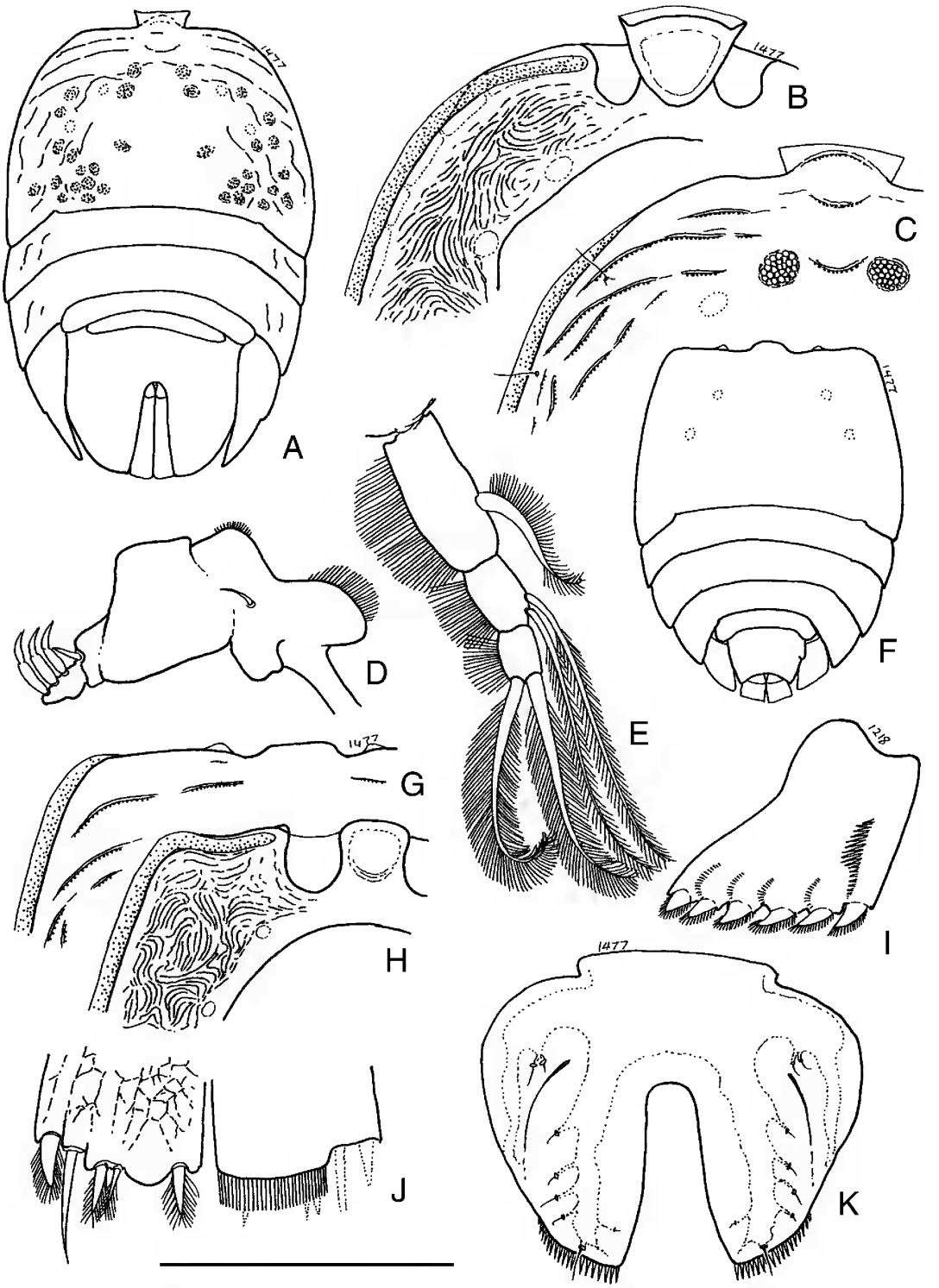

Figure 9. *Dilatatiocauda retroseta* n.sp.: A, female. B,C, anterior of female cephalosome (B, ventral view; C, dorsal view; hyaline border stippled). D, maxilliped. E, male P2 endopod. F, male. G,H, anterior of male cephalosome (G, dorsal focus; H, ventral focus). I, male P5, ventral view. J, detail of female caudal rami showing terminal setae (left dorsal focus, right ventral focus). K, female urosome, dorsal view. Scale bar: A,F = 0.6 mm; B,C,G,H,K = 0.3 mm; D,J = 0.08 mm; E = 0.15 mm; I = 0.133 mm.

species are distinct. The most important difference being the possession of four terminal setae on the male P2 endopod in *P. tristanense*, but only two in *D. retroseta*. The relationship of *P. tristanense* and *D. retroseta* will be considered further in the discussion.

Distribution and abundance. All specimens were collected at Cronulla, Sydney, New South Wales, where they were found associated with the more abundant *D. multidenticulata*. A small population was found on *Dictyopteris* sp. Isolated animals have been collected from *Sargassum* sp., *Ecklonia radiata* and *Cystophora* sp.

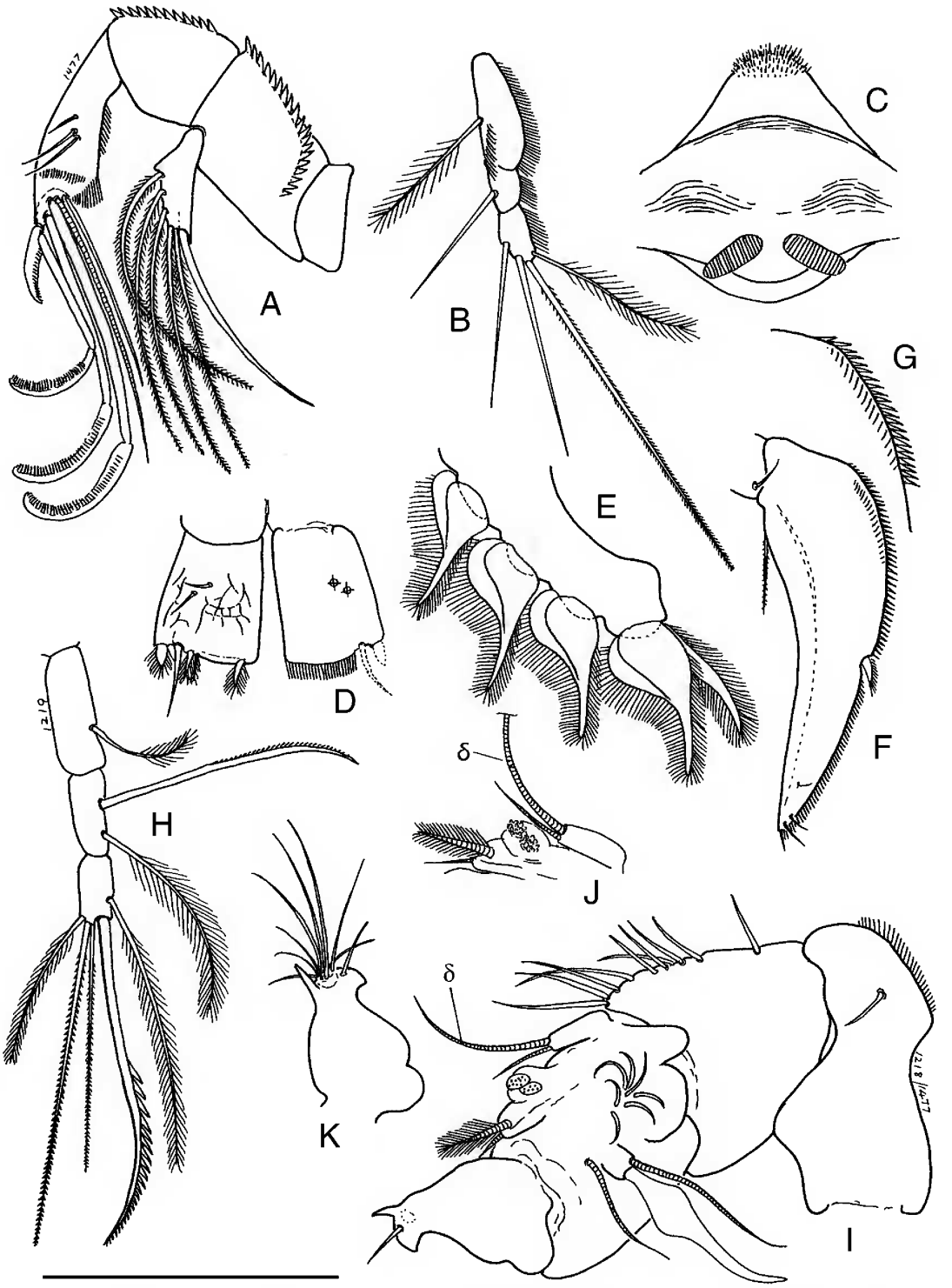

Figure 10. *Dilatatiocauda retroseta* n.sp.: A, antenna. B, P4 endopod. C, combs on labrum. D, male caudal rami. E, posterior lobe of mandibular palp showing wing-like expansion of pilose bulbous setae. F, female P5. G, striations on "shoulder" of P5. H, P3 endopod. I,J,K, male antennule (I, ventral view showing bulbous aesthetasc; J, detail of coupling denticles; K, dactylus). Scale bar: A = 0.125 mm; B,H = 0.15 mm; C,E,I,K = 0.1 mm; D,G = 0.133 mm; F = 0.225 mm; J = 0.08 mm.

Dilatatiocauda bipartita (Kim & Kim, 1997)

Figs. 3, 6, 11, 12

Porcellidium bipartitum Kim & Kim, 1997, 142–148, figs. 1–3.

Material examined. Specimens from Tei, Kochi Prefecture, Shikoku, Japan (33°32'N 133°45'E), (sample 951017) collected by N. Iwasaki: 30 adult ♀♀ (26 ovigerous), 11 adult ♂♂ (4 coupled with juvenile ♀), 6 ♂♂ + 4 ♀♀ copepodites, 88 nauplii. Specimens deposited at NSM Tokyo: ♀ Cr13412, ♂ Cr13413, 2 ♀♀ Cr13414; AM P58800, 1♀; BMNH 2000.1255–1256, 1♀, 1♂.

Diagnosis. *Adult female*: dorsal ornamentation of crescentic pits, no reticulate ridges or honeycomb structures, hyaline border granular; area of hair-like setules anterior to labrum, labrum with kidney-shaped area of denticulate setules in front of comb plates, comb plates with many ridges (>8); sternal plate of metasome segment 4 without fimbriate setules or ridges; caudal rami elongate, rectangular (length c. 3 × width), α and β setae not very close, α seta about ⅓ way down ramus, terminal seta T1 pinnate, setae T2, T3 and T4 plain, terminal fringe of 16 triangular setules; antenna with seta on segment 1 of endopod, geniculate setae not longer than segment 2 of endopod; maxilliped coxa with fimbriate border; lateral denticulate area on P1 endopod small (⅕ width of endopod), small medial denticulate area present; P4 endopod segments 2 and 3 fused, no chitinous striations along anterior-lateral border of P5. *Adult male*: dorsal pits and hyaline border as for female; terminal border of caudal ramus with numerous fine setules; antennule coupling denticles not denticulate, dactylus with terminal hook and single tooth; P2 endopod with two plumose terminal setae; P4 endopod segments 2 and 3 fused; P5 almost rectangular, setae pinnate lanceolate without row of setules at base.

Dimensions. *Females*: mean length (anterior of rostrum to posterior extremity of urosome) 1.45 mm (SD 0.047, *N* = 16), mean width of cephalosome 0.94 mm (SD = 0.026, *N* = 16), body length to width ratio 1.54. Rostrum 0.25 mm, ratio of body width to rostrum 3.76. Urosome width to length ratio 1.44. Caudal ramus length to width ratio 2.86, dilation index 8.2. (A single large female measuring 1.65 mm long, 1.07 mm wide and rostrum 0.027 was washed from *Chondrus giganteus* at Iwaya Port, Awajishima, Hyogo Prefecture, Japan, sample 980525/6, N. Iwasaki). *Males*: mean length 0.98 mm (range 0.97–1.0 mm, 5 animals), mean width 0.79 mm, (range 0.78–0.81 mm, 5 animals).

Description. *Adult female* (Fig. 11A). Pale yellow or colourless. Anterior of cephalosome semicircular, rostrum prominent (projects ⅓ of its width). Crescentic surface pits (2–3 μm diameter) near edge of cephalosome, on urosome, caudal rami and P5. Dorsal fold parallel to anterolateral edge of cephalosome (Fig. 11D). Hyaline border appears granular (22 μm wide). A pad of filiform setules lies anterior to the muscles of the labrum (Fig. 11C). A reniform (kidney-shaped) area of short denticulate setules lies anterior to comb plates on labrum, comb plates with more than 8 ridges. Sternal plate of metasome segment 4 without hair-like setules or ridges. Urosome broad (Fig. 11J), almost semicircular. No notch or cleft but scar indicates boundary between anterior and posterior lobes. Fine setules on distal half of anterior lobe. Posterior lobe wide, medial corner tightly rounded, fine setules along border which pass round medial corner into caudal arch (Korean specimens lack border setules). Two sensory setae present on posterior lobe, but set in from border. Caudal arch deep (58% of urosome length). Anal segment with two dorsal setae (Fig. 11J). Caudal rami (Fig. 6E) elongate, rectangular, sides almost parallel, terminal border between T3 and medial corner convex, short setules along posterior half of lateral and medial edges. Alpha seta medial (Hicks' index 62%, Korean animals 55%). Alpha and beta setae not very close (L/[α–β] = 7). Terminal seta T1 pinnate, setae T2 & T3 very close, plain, T4 plain, set in from medial corner (⅕ ramus width, Fig. 11G), terminal fringe of 16 large triangular setules. Limbs typical of family. Antenna exopod with five plumulose setae and one spinous plumulose seta. Basis and segment 1 of antenna endopod with U-shaped row of triangular setules (Fig. 12A), endopod segment 1 with small plain seta on anterior edge, endopod segment 2 with three lateral setae and six terminal setae, one plain, one long articulate plumulose seta (twice length of longest geniculate seta) and three plain geniculate setae which are shorter than segment 2, the claw is a long comb (as long as shortest geniculate seta). Posterior lobe of mandibular palp with wing-like hyaline expansions to base of the four bulbous setae (cf. Fig. 10E). Medial lobe of maxilliped coxa fimbriate (Fig. 11F). Lateral triangular area of denticles on P1 endopod small (⅕ width of endopod), small area of denticles on medial edge of endopod (Fig. 3E). Spinous seta on segment 2 of P3 endopod (Fig. 12B) strong, serrate, almost as long as endopod (0.9:1), J-shaped spinous seta on segment 3 serrate, longer than endopod (1.3:1), straight spinous terminal seta serrulate, much longer than endopod (1.6:1), internal and external seta on endopod segment 3 short plumose (Fig. 12C). P4 endopod segments 2 and 3 fused (i.e., endopod has only two segments, Fig. 12D), fused segment with three internal serrate spinous setae and long straight serrulate spinous seta. P5 basis with area of short setules on anterior edge (Fig. 11H), fringe of larger setules along posterior edge, dorsal seta plain, two ventral setae (one small plain seta plus longer plumulose seta, Fig. 11I), exopod ovo-lanceolate, anterolateral border without setules or chitinous striations, rest of border with setules. Apical seta present plus one large and two small dorsal setae (Fig. 11H). Females with 16 to 36 eggs in ovisac (mode 24, *N* = 18).

Adult male (Fig. 11B). Colour and surface pits as for female. Anterior of cephalosome truncated, shoulders sharply rounded with epaulet, lateral angle of antennule socket projects and is visible form above (Fig. 11E), rostrum narrow (0.075 mm), cephalosome width to rostrum ratio 10.6, rostrum does not project anteriorly. Crescentic pits near edge of cephalosome and on dorsal surface of caudal rami and P5s. Caudal ramus (Fig. 12G) short (L/W = 0.9), lateral edge convex, dilation index = 45, fine setules along posterior half of medial and lateral edges, terminal fringe of numerous fine setules, setation as for female except for terminal border. Antennule (Fig. 12I), anterior lobe and δ seta lie parallel to anterior edge of compound segment, δ seta projects laterally (not anteriorly). Three coupling denticles are present, they appear to be folded with a finely ridged or crenulated edge, there are two associated articulate plumose setae. Two long strap-like setae bordered with very short plumulae (marked * on Fig. 12I) are found on the ventral surface of the compound segment, one originates among the π setae, the origin of the other is obscured by

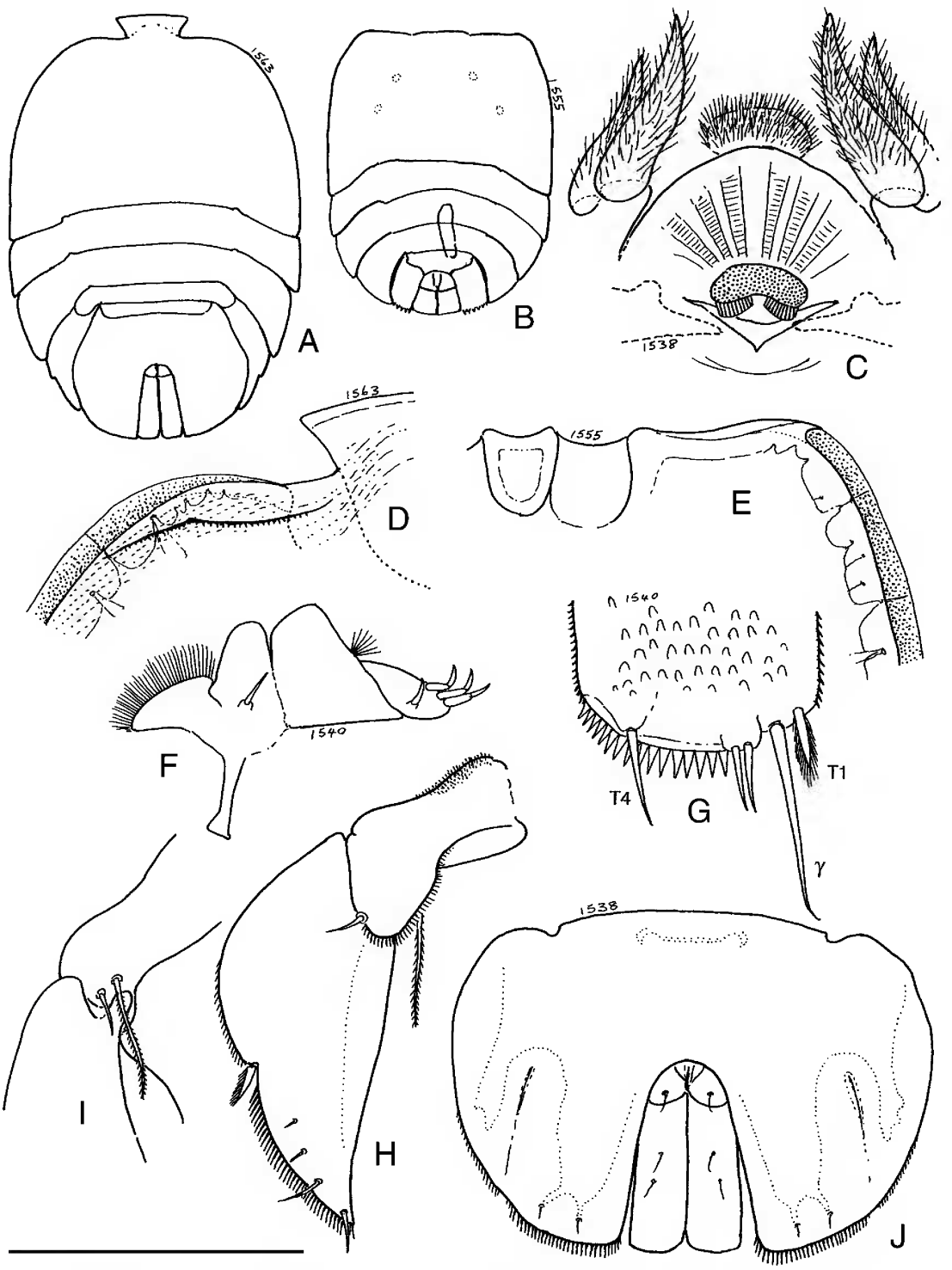

Figure 11. *Dilatatiocauda bipartita* (Kim & Kim, 1997): A, female. B, male. C, labrum showing anterior pad of filiform setules, reniform area of denticulate setules and comb plates. D, anterior of female cephalosome, dorsal view (hyaline border stippled). E, anterior of male cephalosome, ventral view. F, maxilliped. G, detail of terminal setae on female caudal ramus. H, female P5, dorsal view. I, female P5 detail of ventral setae. J, urosome plus caudal rami, showing dorsal setae on anal segment. Scale bar: A,B = 1.0 mm; C = 0.17 mm; D,E = 0.3 mm; F = 0.15 mm; G = 0.25 mm; H,I = 0.225 mm; J = 0.34 mm.

the proximal coupling denticle. Their appearance is unique and suggests that they may be sensory structures (Tiemann (1977) illustrates a similar flat seta on his *P. planum*). A chitinous ventral process or blade is present. The aesthetasc is short (not longer than the dactylus), it does not have a bulbous base. The dactylus has a large basal lobe, a tooth on the lateral edge and a strongly hooked apex (Fig. 12H). Endopod of P2 with two plumose terminal setae (Fig. 12F). P3 and P4 as for female, P4 with segments 2 and 3 fused. P5 (Fig. 12E) almost rectangular, terminal setae pinnate

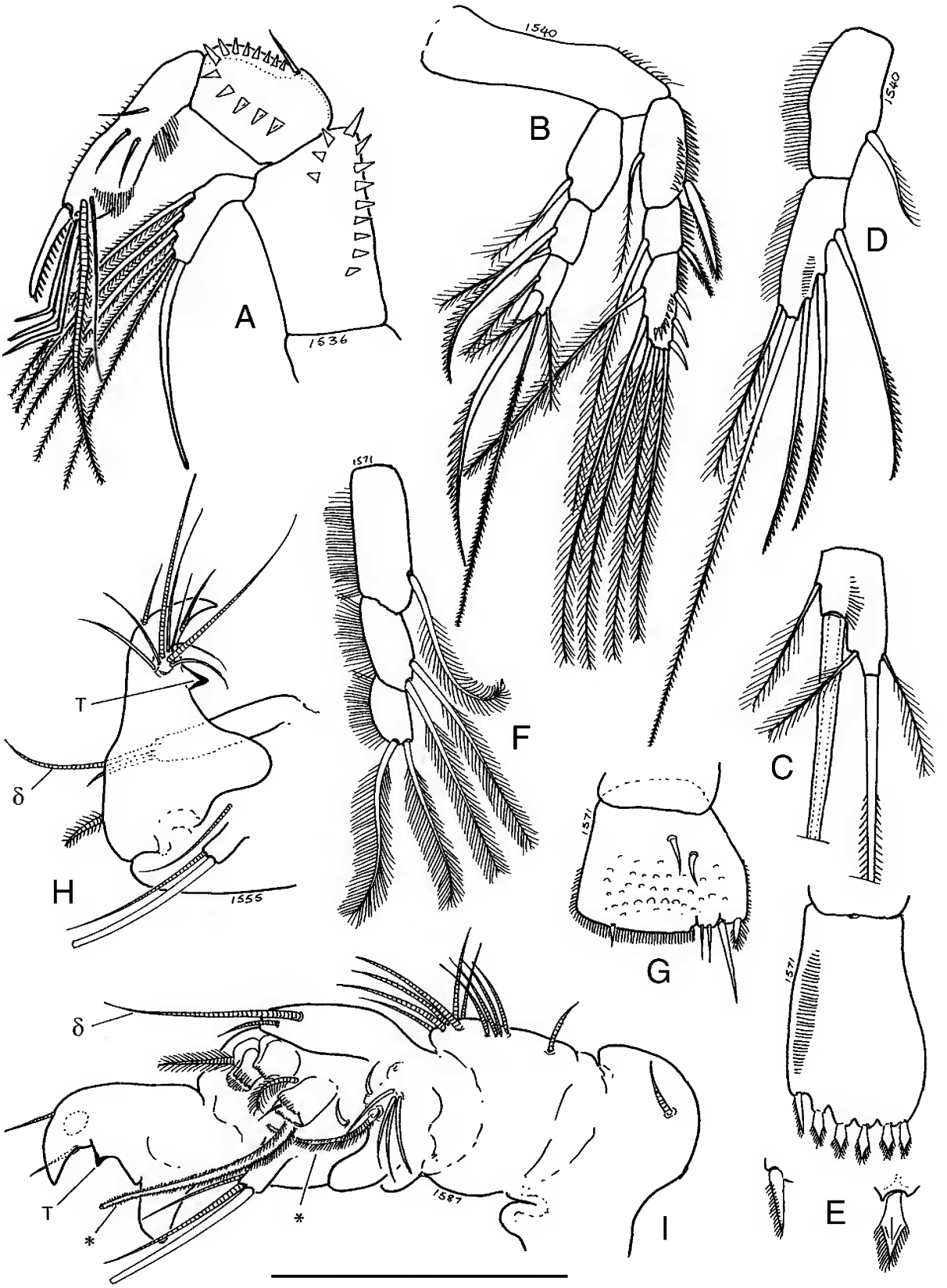

Figure 12. *Dilatatiocauda bipartita* (Kim & Kim, 1997): A, antenna, dorsal view showing seta and surface setules on segment 1 of endopod. B, P3. C, P3, detail of terminal segment of endopod. D, P4 endopod, showing fusion of segments 2 and 3. E, male P5 and enlargement of setae 1 and 6. F, male P2 endopod. G, male right caudal ramus. H, dactylus of male antennule in adducted position (ventral view). I, right male antennule (ventral view) with dactylus fully abducted to show coupling denticles. (T, tooth; δ, delta seta on anterior lobe; * strap-like plumulose setae). Scale bar: A,H = 0.133 mm; B = 0.25 mm; D,E,G = 0.15 mm; F = 0.225 mm.

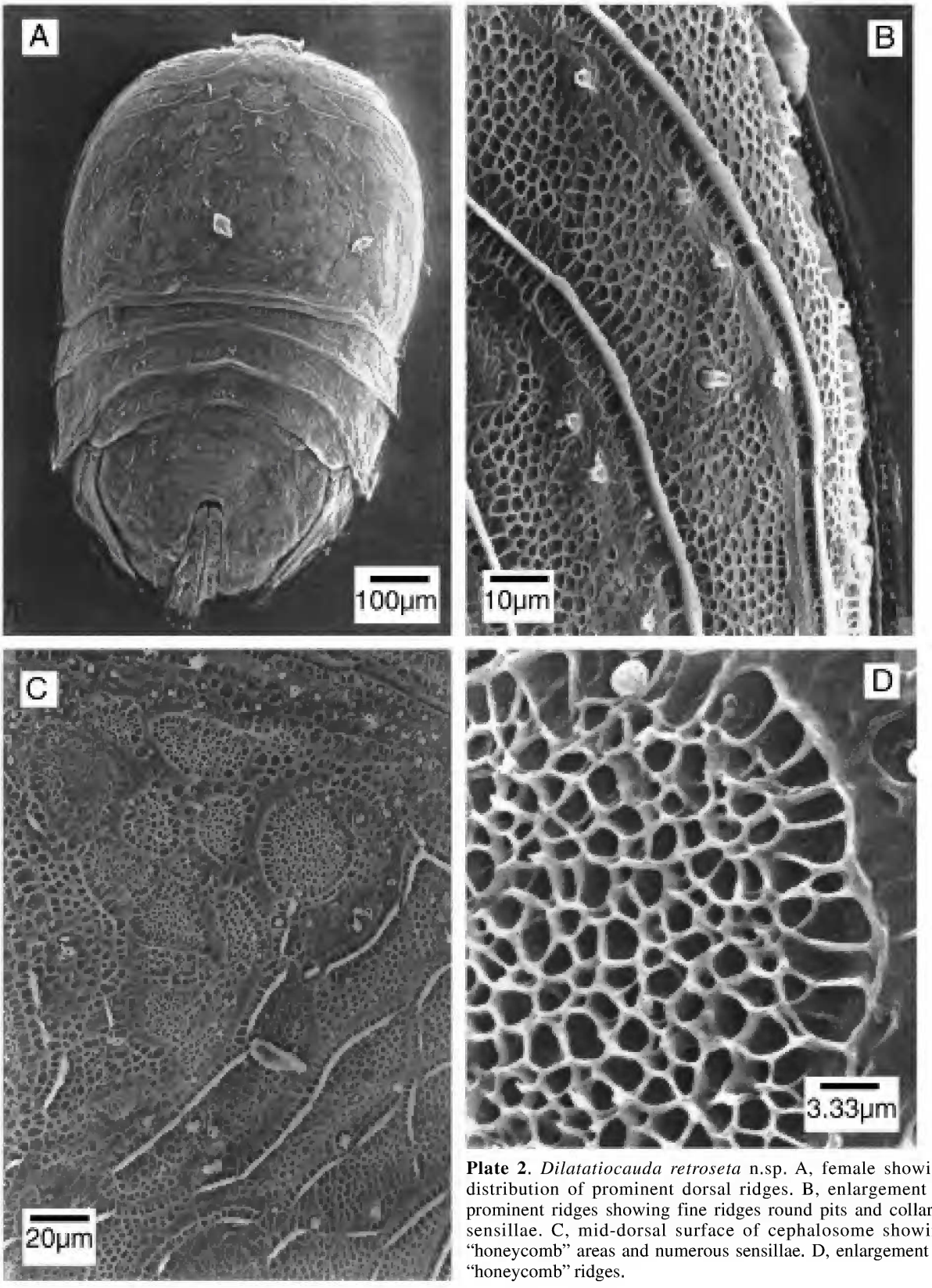

Plate 2. *Dilatatiocauda retroseta* n.sp. A, female showing distribution of prominent dorsal ridges. B, enlargement of prominent ridges showing fine ridges round pits and collared sensillae. C, mid-dorsal surface of cephalosome showing "honeycomb" areas and numerous sensillae. D, enlargement of "honeycomb" ridges.

lanceolate, long row of ventral setules (>20) associated with first (lateral) seta, no setule rows at base of other setae.

Remarks. *Dilatatiocauda bipartita* is unique among the Porcellidiidae in having only two segments to the endopod of the fourth peraeopod in both male and female animals, a fact indicated in the specific name. It is the largest species recorded for the family. Animals from Japan appear to be smaller than those from Korea. Kim & Kim (1997) only give a single measurement for length (♀ = 1.71 mm) without

indicating either the range of variation or the mean value for the population. The mean length of Tei females is 1.45 mm (SD = 0.047, $N = 16$), but a single female from Awajima measured 1.65 mm in length.

Kim & Kim (1997) state that the second limb (P2) endopod of male animals terminates with 2 or 3 setae. Data is not given as to the frequency of the 3-seta condition in the population, nor is it stated which of the four setae found in females has been lost. All Japanese specimens have only two plumose terminal setae on the male P2 endopod and this must be considered the normal condition.

Dilatatiocauda bipartita shows a remarkable resemblance to the animal described by Tiemann (1977) as *Porcellidium planum*. The two animals share the following unique features: the antennule of males have two long strap-like plumulose setae and similarly shaped dactylus; antennae have an anterior seta on endopod segment 1; the coxa of maxilliped is fimbriate and the area of denticulate pegs on P1 endopod is similar; the unusual shape and setation of P3 endopod and male P5 are virtually identical. However, the following significant differences show that the two species are distinct: *P. planum* has the α seta on caudal ramus proximally situated and very close to β (L/[α–β] = 35); the maxilliped basis has a fimbriate border; the terminal segment of male P2 has four setae (one spinous, three plumose); segments of P4 endopod are not fused (there are three segments). The significance of these differences will be considered in the discussion.

Distribution. Animals collected by N. Iwasaki at Tei, Kochi Prefecture were washed from *Ecklonia cava*. A single female was found in washings from *Chondrus giganteus* collected at Iwaya Port, Awajishima, Hyogo Prefecture. The species has also been collected from *Ecklonia cava* at Chojagasaki, Kanagawa Prefecture by Yuka (Tadasugi) Sasaki and at Hamajima, Mie Prefecture by Hiroshi Ito (specimens in possession of Yuka (Tadasugi) Sasaki examined by author). Despite extensive sampling at Kadonohama Bay, Ofunato, Iwate Prefecture, *D. bipartita* has not been found there. This suggests that it is a southern species distributed along the southern coast of Honshu, Shikoku and in the Korea Strait.

Discussion

The family Porcellidiidae has long been regarded as monotypic with one genus, *Porcellidium*. Huys *et al.*, (1996) have emphasised this point of view by making the diagnosis of the genus *Porcellidium* identical to their diagnosis of the family. They rejected new genera proposed by Harris (1994) and Harris & Robertson (1994), "... on the grounds that creation of new genera should wait a revision of the type-genus *Porcellidium*", Bodin (1997). The validity of this point of view and justification for establishing the new genus *Dilatatiocauda* need to be considered.

Table 1. Comparison between *Dilatatiocauda* species

	characters	*dilatatia*	*multidenticulata*	*medialis*	*retroseta*	*tristanensis*	*plana*	*bipartita*
1	**caudal ramus**							
	Hicks' Index for α seta	H = 73%	H = 80%	H = 55%	H = 33%	H = 38%	H = 68%	H = 62%
	setules on lateral and medial edge	absent	absent	absent	absent	present	present	present
2	**male antennule**							
	lobe to dactylus	yes	yes	yes	yes	no	yes	yes
	2 strap-like plumulose setae	absent	absent	absent	absent	absent	?present	present
3	**antenna**							
	seta on segment 1 of endopod	no	no	no	no	no	yes	yes
	longest geniculate seta on segment 2 of endopod	= seg 2 length	= seg 2 length	= seg 2 length	2 × seg 2 length	2 × seg 2 length	= seg 2 length	< seg 2 length
	shape of geniculate setae	L-shaped	L-shaped	L-shaped	J-shaped pectinate	J-shaped pectinate	L-shaped	L-shaped
4	**P1**							
	lateral denticulate area	large (> ½ width)	large (> ½ width)	small (< ½ width)	large (> ½ width)	large (> ½ width)	small (< ½ width)	small (½ width)
	medial denticulate area	absent	absent	absent	present	present	absent	present
5	**male P2**							
	terminal setae	2 setae	2 setae	2 setae	2 setae	4 setae	4 setae	2 setae
6	**male P5**							
	setules at base of terminal setae	present	absent	absent	present	present	absent	absent

Three strong reasons for accepting more than one genus in the family can be given. Firstly the number of known species (either published or studied in considerable detail by the author) now exceeds 70. This provides a greatly expanded data base and deeper insight into the range of characters available for taxonomic study. Many new structures have been found which add weight to the opinion that the family embraces more than one genus.

Secondly, judging from the characters chosen by Huys *et al.*, (1996), their diagnosis of the family appears to be based primarily on the European species and excludes many species from other parts of the world. For example, *Porcellidium ravanae* Thompson & Scott, 1903, *P. clavigerum* Pesta, 1935, *P. tristanense* Wiborg, 1964, *P. trisetosum* Geddes, 1968, *P. planum* Tiemann, 1977, *P. laurencium* Hicks, 1982, *P. ulvum* Hicks, 1982, *Murramia magna* Harris, 1994, *M. bicincta* Harris, 1994 and *Kioloaria sesquimaculata* Harris, 1994 are all excluded from *Porcellidium* on the number of terminal setae found on the male P2 endopod. *Porcellidium unicus* Ummerkutty, 1970, is excluded on the number of setae on the male P5 exopod. Other species are excluded for different reasons. This problem can be solved in two ways. Either the misfits are moved to new families or the family is redefined to include new genera for those species that do not fit *Porcellidium*.

Splitting off some species into new families does not seem justified. Members of the Porcellidiidae are highly specialized for dwelling on the surface of seaweeds in the littoral and sub-littoral zones where they are subject to severe wave movement. All species are remarkably similar in shape and structure and no major differences have been found that would suggest the Porcellidiidae should be split into several families.

Thirdly, several clearly defined species groups have been found in which members share a cluster of unique (apomorphic) characters that are not fond elsewhere in the Porcellidiidae. Hicks (1982) was the first to point out that *Porcellidium clavigerum*, *P. echinophylum* Humes & Gelerman, 1962, *P. laurencium* and *P. ulvum* form a natural group, the "clavigerum complex", which is characterised by lateral striations on the female urosome and caudal rami with four equally spaced clavate terminal setae. Hicks' "clavigerum complex" was raised to generic status as *Clavigofera* Harris & Iwasaki, 1996b with the addition of another species from Japan and Australia.

Other "complexes" have been described. Two species from Australia possess an unusual modification in which the lateral edge of the cephalosome is reflexed ventrally. This has resulted in loss of the true hyaline border and migration of the eight border sensillae to the underside of the carapace. Ducts from the marginal glands, which open dorsal to the hyaline border in all other species, now open ventrally. These undoubted apomorphic characters, together with other peculiarities, form a character set that is unique and justifies generic status. These species were placed in the genus *Tectacingulum* Harris, 1994, (L. *tectus* = hidden + *cingula* = a girdle).

Another "species complex" comprises three species from Japan and one from Australia in which the male antennule bears a "comb" on the anterior edge of the compound segment. They are further characterised by pentagonal caudal rami and a ventral fold on the female P5 exopod that lies under the edge of the urosome. Again, these features appear good apomorphic characters and, together with other unique features, constitute a character set that defines this "complex". It has been given the generic name *Kushia* Harris & Iwasaki, 1996b (derived from the Japanese *kushi* = a comb).

The new species described in this paper are distinguished from all other members of the Porcellidiidae by the unique structure of their maxillipeds. This, together with other unusual features described, provide an unique set of apomorphic characters that define another discrete group of species for which the generic name *Dilatatiocauda* seems justified.

Huys *et al.*, (1996) rejected Australian genera proposed by Harris (1994) and Harris & Robertson (1994), in the belief that they were "based on dubious grounds". In the case of *Kioloaria* and *Brevifrons* Harris, 1994, their criticism may be justified because only one species is presently known in each of the proposed genera. However, in the case of *Tectacingulum, Kushia* and *Dilatatiocauda*, the set of diagnostic characters chosen to define the new genera were discovered on single species in the first instance. In each case a new species had been found that possessed several unique features, unknown elsewhere in the family. This suggested the existence of a new group or complex. At a later date this was confirmed when other new species were found that possessed the same unique character set.

Selection of a character set from a single species to define a new complex is highly subjective. It is based upon the belief that the unique characters chosen are apomorphic and beyond the range of trivial variations that distinguish species. Such beliefs will be confirmed (and the erection of new genera justified) if and when new species are discovered that possess the same character set. An example of this is given by *Kensakia* Harris & Iwasaki, 1997. The genus was created to accommodate a single species from Kadonohama Bay, Ofunato, Japan. Since publication, two new species (not yet described) have been discovered (one from Japan and another from Queensland, Australia) that possess the same character set and, therefore, belong to *Kensakia*. This demonstrates that creating new genera on the strength of a single species may be justified provided suitable apomorphies can be recognised.

Erecting new genera should not prejudice or interfere with a revision of the type genus, *Porcellidium* for, by definition, they will be based on characters that *Porcellidium* does not share.

Unfortunately, all early descriptions of species paid little attention to male animals even though males display many valuable taxonomic features. Indeed, in cases where distinguishing between females of two different species is difficult or impossible, males show clear-cut differences that allow immediate and positive identification.

The adult male antennule is of particular importance in identification. Hicks (1982) was the first to suggest that this organ might be of taxonomic value. Harris (1994) compared the setation of male and female copepodites and studied the changes that occur during metamorphosis to the adult. He showed that several chitinous structures (referred to as coupling denticles) arise *de novo* at the time of the male's final moult and are species specific. At that time they were not regarded as useful for identification because they are difficult to see when the dactylus is in the adducted position, but better techniques have enabled this important

organ to be studied in detail. Besides the wide range of species-specific coupling structures found, it was discovered that the male antennule may show apomorphic characters. This was first demonstrated in the genus *Kushia*, but it has now been confirmed for *Murramia* and *Tectacingulum*—Harris (1994), *Clavigofera* and *Kensakia*—Harris & Iwasaki (1996b, 1997), and *Dilatatiocauda* . Structure of the male antennule, together with other male characters, should play a major role in future descriptions of new species and revision of the Porcellidiidae.

Two previously described species, *Porcellidium tristanense* Wiborg, 1964 and *P. planum* Tiemann, 1977, possess many of the characteristics of *Dilatatiocauda*, but differ in one important feature: both species have four terminal setae on the male P2 endopod. Females of all species within the Porcellidiidae have four terminal setae on the P2 endopod, but male animals have either two or three setae. The five species of *Dilatatiocauda* described above all have two terminal setae. Hicks (1982) considered the possession of four setae on the male P2 of *P. tristanense* a primitive condition and regarded it as a plesiomorphic character. The same argument might be applied to *P. planum*. This explanation clears the way for these two species to be included in *Dilatatiocauda* as *D. tristanensis* (Wiborg, 1964) and *D. plana* (Tiemann, 1977).

Although *D. tristanensis* and *D. plana* have the same unique setation of the male's P2, they share few other similarities. Table 1, gives a comparison of several characteristics between the species of *Dilatatiocauda*. *Dilatatiocauda plana* shares many more features with *D. bipartita* than other species, *D. retroseta* and *D. tristanensis* closely resemble each other, and *D. multidenticulata* and *D. dilatata* are very similar. These striking similarities reinforce the idea that all are closely related and should be included in the same genus.

ACKNOWLEDGMENTS I wish to thank Dr S. Stowe, Australian National University Electron Microscope Unit for her helpful advice and assistance whilst studying specimens with the Hitachi S-255 scanning electron microscope; Dr Nozomu Iwasaki for allowing me to work on *Dilatatiocauda bipartita* material from Shikoku, Japan and specimens of the species from other parts of Japan, also for his helpful comments and corrections to the manuscript; Dr Hicks for paratype specimens of *Porcellidium dilatatum* from Wellington and Yuka (Tadasugi) Sasaki for allowing me to examine her specimens of *D. bipartita*, *Kensakia* sp., and other Japanese material. I am grateful to the referees of this paper for their constructive comments, corrections and criticism.

References

Bodin, P., 1997. Catalogue of the new marine Harpacticoid Copepods (1997 Edition). *Documents de travail de l'Institut des Sciences naturelles de Belgique* 89.

Geddes, D.C., 1968. Marine biological investigations in the Bahamas. 7. Harpacticoid copepods belonging to the families Porcellidiidae Sars, Peltidiidae Sars, and Tegastidae Sars. *Sarsia* 35: 9–56.

Harris, V.A., 1994. New species belonging to the family Porcellidiidae (Harpacticoida: Copepoda) from Kioloa, New South Wales, Australia. *Records of the Australian Museum* 46(3): 303–340.

Harris, V.A., & N. Iwasaki, 1996a. Three new species of *Porcellidium* (Crustacea, Copepoda, Harpacticoida) from Iwate Prefecture, Japan. *Bulletin of the National Science Museum, Tokyo*, Ser. A, 22(3): 133–152.

Harris, V.A., & N. Iwasaki, 1996b. Two new genera belonging to the family Porcellidiidae (Crustacea, Copepoda, Harpacticoida) from Iwate Prefecture, Japan. *Bulletin of the National Science Museum, Tokyo*, Ser. A, 22(4): 199–218.

Harris, V.A., & N. Iwasaki, 1997. A new species of *Porcellidium* and two new genera belonging to the family Porcellidiidae (Crustacea, Copepoda, Harpacticoida) from Iwate Prefecture, Japan. *Bulletin of the National Science Museum, Tokyo*, Ser. A, 23(3): 131–147.

Harris, V.A., & H.M. Robertson, 1994. New species belonging to the Porcellidiidae (Harpacticoida, Copepoda) from the Southern Coast of New South Wales, Australia. *Records of the Australian Museum* 46(3): 257–301.

Hicks, G.R.F., 1971. Some littoral harpacticoid copepods, including five new species, from Wellington, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 5: 86–119.

Hicks, G.R.F., 1982. Porcellidiidae and Peltidiidae (Copepoda: Harpacticoida) from the marine algae of St Croix Island, Algoa Bay, South Africa. *Zoological Journal of the Linnean Society* 75: 49–90.

Humes, A.G., & P.H. Gelerman, 1962. A new species of *Porcellidium* (Copepoda, Harpacticoida) from a sea urchin in Madagascar. *Crustaceana* 4: 311–319.

Huys, R., J.M. Gee, C.G. Moore & R. Hamond, 1996. Marine and brackish water harpacticoid copepods. Part 1. In *Synopses of the British Fauna* (New Series), D.M. Kermack, R.S.K. Barnes & J.H. Crothers eds., London, pp. 352.

Kim, I.-H., & H.-S. Kim, 1997. Harpacticoid copepods of the genus *Porcellidium* associated with marine macroalgae in the seas of Korea. *Korean Journal of Systematic Zoology* 13: 141–172.

Pesta, O., 1935. Marine Harpacticiden aus dem Hawaiischen Inselgebeit, II Beitrag. *Zoologisch Jahrbücher Abteilung Systematik* 66: 363–379.

Sars, G.O., 1904. *An Account of the Crustacea of Norway*. V. Copepoda Harpacticoida. Bergen.

Thompson, I.C., & A. Scott, 1903. Report to the Government on Ceylon pearl fisheries, pt. 1., supplement 7. Report on Copepoda. London.

Tiemann, H., 1977. *Porcellidium planum* n.sp. aus dem Felslitoral Mocambiques (Copepoda, Harpacticoida). *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 74: 69–76.

Tiemann, H., 1978. *Porcellidium peniculiferum* n.sp. und *Porcellidium hartmannorum* n.sp. aus dem Felslitoral der südwestafrikanischen Küste (Copepoda, Harpacticoida). *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 75: 235–248.

Ummerkutty, A.N.P., 1970. Studies on Indian copepods. 10. *Parapeltidium nichollsi* sp. n., *Porcellidium unicus* sp. n., and *Echinolaophonte tropica* sp. n., obtained from the south-east coast of India. *Records of the zoological survey of India* 64: 153–162.

Wiborg, K.F., 1964. Marine copepods of Tristan da Cunha. *Results of the Norwegian Scientific Expedition to Tristan da Cunha 1937–1938* 51: 1–44.

Manuscript received 16 June 2000, revised 8 January 2001 and accepted 19 February 2001.

Associate Editor: G.D.F. Wilson.